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How Effective is Low Vision Service Provision? A Systematic Review

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Abstract.

Visual impairment is a large and growing socioeconomic problem. Good evidence on rehabilitation outcomes is required to guide service development and improve the lives of people with sight loss. Of the 478 potentially relevant articles identified, only 58 studies met our liberal inclusion criteria, and of these only 7 were randomized controlled trials. Although the literature is sufficient to confirm that rehabilitation services result in improved clinical and functional ability outcomes, the effects on mood, vision-related quality of life (QoL) and health-related QoL are less clear. There are some good data on the performance of particular types of intervention, but almost no useful data about outcomes in children, those of working age and other minority groups. There were no reports on cost effectiveness. Overall, the number of well designed and adequately reported studies is pitifully small; visual rehabilitation research needs higher quality research. We highlight study design and reporting considerations and suggest a future research agenda.

Key words.

Low vision, rehabilitation, review, visual impairment, outcomes, QoL, children, economic

I. Introduction

The World Health Organisation estimates that over 135 million people are visually disabled, and nearly 45 million people are blind.[38] Visual impairment is a global concern that is likely to become more significant as the standard of medical care improves and the average lifespan increases.[37,A] Low vision rehabilitation aims to improve the lives of people with sight loss by improving functional ability, and possibly more general aspects, such as quality-of-life and psychosocial status. Different rehabilitation models have been developed to meet these goals, and there is need for a strong evidence base regarding the ability of these different strategies to achieve positive outcomes in various patient groups. We provide a critical evaluation of the current literature regarding the effectiveness of different models of low vision service provision. It complements recent literature reviews that have analysed the effectiveness of specific aspects of rehabilitation for individuals with visual impairment, for example assistive technologies [80,152] and orientation and mobility training.[153]

We first discuss some of the factors that are central to the analysis and understanding of this body of literature, such as the consequences of visual impairment (see Section II A), the different types of low vision services available (Section II B), and types of outcome measures used to assess the effectiveness of visual rehabilitation (Section II C). Section III provides an overview of the included studies, with an emphasis on evaluation of the quality of the studies with respect to robustness of study design. Section IV of the review (parts A-F) summarises the evidence regarding the effect of low vision service provision on different types of outcome. We also evaluate the evidence within the literature to answer other important questions; i) Do some models of service provision improve outcomes more than others? (Section IV G) ii) Do rehabilitation outcomes deteriorate with time? (Section IV H) iii) Does length of rehabilitation affect outcome? (Section IV I) iv) How effective are services at helping children, people with learning disabilities, those of working age, and minority groups with visual disabilities? (Section IV J) v) How cost-effective is low vision service provision? (Section IV K).

Terms such as ‘disability’, ‘impairment’, ‘low vision’, and ‘blindness’ are widely used in the literature. In this review, we define ‘disability’ in accordance with the Equalities Act (2010), [B] which states that a person has a disability if (a) they have a physical or mental impairment, and (b) the impairment has a substantial and long-term adverse effect on the individual’s ability to carry out normal daily activities. For example, reduced visual acuity may be described as an impairment, while the inability to read consequent to the reduced acuity may be described as a disability. Criteria for ‘visual impairment’ and ‘blindness’ vary between the included studies and, where relevant, we address the level of impairment of included individuals. .

II. Measuring the Effectiveness of Vision Rehabilitation

A. CONSEQUENCES OF VISUAL IMPAIRMENT

The ability of individuals with an impairment to function independently is often assessed with reference to their ability to perform everyday tasks. Activities of Daily Living (ADLs) can be defined as tasks that are performed on a normal daily basis, including self-care, social activities, mobility tasks, leisure pursuits, and work. A distinction is often made between basic ADLs, consisting of necessary self-care tasks, such as eating and personal hygiene, and instrumental ADLs (IADLs), which are not necessary for fundamental existence, but which facilitate independent and integrated functioning within a community, for example doing light housework, preparing meals, taking prescription medicines, and taking care of personal finances.[82]

There is considerable evidence that adults who are visually impaired have a poorer functional status in terms of ability to carry out both ADLs and IADLs than their fully sighted counterparts.[18,19,35,67,83,90,159] Lamoureux et al, for example, investigated the limitations in ADLs in 319 participants with a visual impairment with no visual rehabilitation history and found that reading, outdoor mobility, participation in leisure activities, and shopping were most limited.[90] Restricted mobility and orientation skills in individuals with visual impairment also make them more vulnerable to falls and associated complications such as hip fractures.[79,96]

In addition to the functional disability associated with vision loss, it is becoming increasingly apparent that the psychosocial impact of visual impairment is also substantial.[5,21,54,75,77,120] The incidence of depression in visually impaired older adults varies across studies. For example, Evans et al investigated the association between visual impairment and depression in 13,900 people aged over 75 years in the UK; 13.5% of people with visual impairment were found to have significant depressive symptoms compared to 4.6% with good vision.[54] Brody et al found the prevalence of a depressive disorder to be 32.5% in 151 older adults in the USA with visual impairment from bilateral macular degeneration,[21] while Horowitz et al found that, of 584 American patients with vision loss presenting for rehabilitation services, 7% had major depression and 26.9% met the criteria for subthreshold depression.[77] In addition to the direct detrimental effect exerted by depressive disorders on quality-of-life, psychological status has also been shown to impact on an individual's level of functional impairment.[21,90,120,130]

There is less evidence regarding the impact of visual impairment on younger adults and children; however, it has been suggested that the risk of mental health problems associated with visual impairment is at least as high in those of working age as in older adults.[13,14] One recent study suggested that visual impairment occurring in middle age, rather than in later life, is more disruptive

and associated with a greater risk of negative consequences for the individual.[16] A study investigating health related quality-of-life in 79 children with visual impairments, found that there was a wide range of scores on the Health Utilities Index and that the outcome was related to the co-morbidities of the individuals. For example, children who only had nystagmus had significantly better health-related quality of life scores, while those who had additional impairments reported significantly lower scores than those who only had a disorder of the eye/visual pathway.[17]

The combination of social, functional, and psychological disabilities attributable to visual impairment has been shown to result in an overall reduction in quality-of-life [25,86] and an increased mortality rate.[94] However, in an environment where economic resources for healthcare are limited, and cost effectiveness must be demonstrated, the economic impact of visual impairment and associated disabilities is also an important consideration. Frick et al used the Medical Expenditure Panel Survey data from 1996-2002 to estimate the economic burden of visual impairment and blindness in the United States.[58] Through calculating the excess costs associated with visual impairment for an average individual, and estimating the prevalence of visual impairment and blindness, they suggested that excess expenditures of $2.8 billion were directly attributable to vision loss in those with visual impairment and blindness. The main contributor to this expense was home care. Furthermore, when the loss of quality adjusted life years was added to the equation, a total annual impact of nearly $16 billion was calculated.

B. VISION REHABILITATION SERVICES

Vision rehabilitation services conform to a variety of different models, some addressing solely the functional needs of the individual, with an emphasis on the provision of optical and non-optical aids, while others adopt a more holistic approach. Frequently encountered service types in studies included in this review included standard hospital-based services (provided by optometrists or trained low vision therapists, although these services now also often offer a high level of integration, including strong links to the social services);[36,154] integrated or multi-disciplinary services (including extra elements such as counselling, group activity, occupational therapy, orientation and mobility training);[66,91,102,143] and services with an emphasis on the psychological needs of patients.[105] Services could be inpatient [51,105] or outpatient, [110,143] and could be designed to cater for the needs of a particular patient group, for example children,[121] older adults,[73] or veterans.[61,105,137,143]

With regard to the personnel who provide low vision services, traditional UK hospital-based low vision services rely primarily on optometrists, with referral to other professionals as necessary. In recent years, however, a range of professionals have worked alongside, or in the place of, the optometrists in providing these low vision services. A report by the Agency for Healthcare

Research and Quality (ARHQ) in the USA gave an overview of licensed and unlicensed professionals currently involved in low vision provision, which included, in addition to ophthalmologists and optometrists, occupational therapists, physical therapists, social workers, low vision therapists, vision rehabilitation teachers, and orientation and mobility specialists.[C] In some services, this wider-reaching approach to low vision service provision has culminated in the development of multidisciplinary/interdisciplinary or integrated low vision services.[43,66,70,91,102,104,140,143] The exact nature of the multidisciplinary approach, however, is often poorly defined. Multidisciplinary models vary widely in their composition, but often include a mixture of healthcare professionals, including those described by the AHRQ, as well as psychologists and/or counsellors, combined in an integrated service. There is no clear distinction in the literature between so called multidisciplinary and interdisciplinary services, with both terms applied to services that employ professionals from different disciplines within the rehabilitation process. A further type of integrated model which has been described is the transdisciplinary service,[68] which also involves a collaborative team, but uses extensive cross-training and role release (Team members refer aspects of training to colleagues from different disciplines.).

Several novel group-based programs-have also been described. Horowitz et al, for example, identified an "Adaptive Skills Training Programme" based entirely on a group model of instruction and facilitated discussion addressing different aspects of rehabilitation, including ADLs, orientation and mobility, communication skills, and maintaining independence.[73] A similar group approach has also been adopted in Europe, with the addition of a homework component and invited professional speakers, e.g. ophthalmologists and lighting specialists.[41,48,49] Self-management programs are becoming increasingly popular, adopting a group-based approach, with the aim of helping participants to take control in managing the consequences of visual impairment and developing problem solving skills through sharing experiences and coping strategies.[22,23,60,109,114] Given the wealth of different strategies employed in providing vision rehabilitation, there is a real need for evidence-based studies evaluating the effectiveness and cost-effectiveness of the various types of rehabilitation.

C. OUTCOME MEASURES FOR ASSESSING THE EFFECTIVENESS OF A SERVICE

The effectiveness of low vision service provision has been assessed in numerous ways, with little consensus on the best approach. For example, we identified 47 different outcome measures in the studies included in this review (see Table 1). This lack of consensus is problematic because it hinders cross study comparisons.

Early studies tended to judge the outcomes of a service by either evaluating the frequency of use of low vision aids by patients at follow-up of a variable period[103,131,150] or by assessing clinical

measures of visual function, such as visual acuity or reading speed.[69,93,100,107] Although clinical outcomes are important, they do not necessarily reflect the abilities that the patients will show in their home environment; for example, a large discrepancy has been demonstrated between individuals with a good near VA in the clinic (75%), and those able to resolve small print at home (39%).[93]

From this review, it was apparent that in the past decade there has been a drive towards assessing outcomes based on measures of ability and/or independence in performing daily tasks,[48,65,110] on measures of psychological status,[52,72,75] or on patient-reported quality-of-life.[43,70,91,115] Instruments assessing functional status may be scored entirely based on a patient's judgment of their own ability (self-report/patient-rated assessment), e.g. the Veterans Affairs LV VFQ-48,[141] or may be completed by a single clinician, or group of professionals (provider/clinician-rated assessment), e.g. the Independent Living Pre- and Post- Programme Assessment ILPPA,[144] while other tools combine the two, with some self-rated and some clinician-rated items, e.g. the Melbourne Low Vision ADL Index (MLVAI).[66] Another type of tool is the proxy-based assessment, which relies on the judgement of a family member, or someone close to the patient. This approach has been used more commonly in assessing outcomes of children or those with learning disabilities.[9]

In recent years, the term 'quality-of-life' (QoL) has been widely used in vision rehabilitation outcome studies. There is no single definition of quality-of-life, and the parameters assessed are often context dependent. Numerous generic tools are available for the assessment of health-related QoL: the Sickness Impact Profile (SIP),[4] the Medical Outcomes Short Form 36 (SF-36),[157] and the EQ-5D from the Euroqol group[111] are widely used examples. Other vision-specific QoL measures, including the Low Vision Quality-of-Life questionnaire (LVQOL)[160] and the National Eye Institute Visual Function Questionnaire (NEI-VFQ)[99] have been developed. These questionnaires often combine general quality-of-life type measures (e.g. psychosocial adjustment), with domains concerned with vision-related functional ability. Early questionnaires were largely designed to assess functional impairment of people with cataracts e.g. the VF-14,[133] and the Visual Functions Index,[6] and it cannot be assumed that content validity of a questionnaire will be sustained when the tool is transferred to a different patient population e.g. to a group of visually impaired people with mixed diagnoses. In contrast, the LVQOL,[160] Vision Quality-of-life Core Measure (VCM-1),[59] and the NEI-VFQ [98,99] were developed to be used with patients representing a broad range of ocular conditions that had caused vision loss.

Self-rated and parent-rated visual function and quality-of-life outcome measures have also been developed specifically to evaluate outcomes in children with visual impairment and blindness.[9,27,62,84] For example, the 25-item Cardiff Visual Ability Questionnaire for Children

(CVAQC) assesses self-reported visual ability in children and young people with a visual impairment.[84]

One important function of outcomes research is to assess the cost effectiveness of health and social care interventions so that policy makers can make judgments about a particular treatment/intervention.[46] Evidence of cost effectiveness is increasingly being used by decision makers, such as NICE, to make recommendations for resource allocation in the NHS.[D] "Quality-adjusted life years" (QALYs) are an index of health gain combining length and quality of life.[20] The costs of providing the intervention are calculated and compared with the QALY to generate the additional costs required for one year of full health (one QALY). NICE supports the use of QALYs as a generic measure of health gain, allowing comparison across different health services and patient groups.[E] Further information about the outcome measures used by studies included in this report is provided in Table 1.

Assessing the effectiveness of vision rehabilitation usually requires data to be collected on at least two occasions i.e. pre- and post- intervention. The baseline measure is generally taken immediately prior to the commencement of the rehabilitation service; however the timing of the follow-up measure may be variable. Implementation immediately after discharge from the service is one approach,[140] while others choose to obtain post-test data several months after the conclusion of the rehabilitation process.[88,89] The timing of the follow up outcome measure is important because improvements in the trait being assessed resulting from low vision service provision may be offset by a deterioration in visual function caused by pathology progression.

Wolffsohn et al investigated the change in vision-related quality-of-life scores (LVQOL) in 117 people assessed at 4 time points (at time 0, 4 weeks, 8 weeks, and 12 weeks).[161] They found a trend towards a reduction in quality-of-life scores 3 months after baseline measures were implemented and suggested that outcomes should be assessed up to 2 months post-rehabilitation to avoid a significant decrease in the baseline level of visual impairment during the study period. A large no-treatment condition matched "control" group, however, provides the only reliable means of teasing out the effects of intervention and disease progression.[138]

III. Quality of included Studies

Of the 9,500 'hits' identified by the literature search, 478 were potentially relevant to this study, of which only 58 were found to meet inclusion/exclusion criteria (section VIII). Of these, 52 were relevant to the general effectiveness of low vision services, 4 to children and minority groups, and 2 to health economic evaluations of visual rehabilitation.

Figure 1 shows the breakdown of included studies by study design. Fifty two studies are included in Figure 1 as several manuscripts presented data from the same studies (see Table 2 of included studies).[15,41,43,48-50,75,145,149] The majority of included studies used a "before and after" design but lacked a "control" group. This design made it difficult to determine the effect of the intervention in many cases, as it was not possible to determine the underlying deterioration in function associated with a worsening of the disease condition over the time-course of the study. Only 7 of the studies described a randomised controlled trial (RCT), and several of these had significant design or reporting flaws. For example, Scanlan and Cuddeford carried out an RCT to determine the effectiveness of a low vision service model which used a prolonged period of education by a rehabilitation worker, compared to the current standard service.[126] The potential value of this study was marred by the small sample size (N=32 per group), by a lack of clarity about how loss of subjects to follow up may have affected outcomes, and, crucially, by a lack of actual mean scores and standard deviations reported in the paper. Rogers et al, who carried out a retrospective controlled before and after study to compare two different models of low vision rehabilitation, similarly failed to provide any actual data, reporting only P values in the article.[118] Engel et al, in their before and after study, referred to a significant correlation between dose of rehabilitative intervention and outcome, but gave no details of the magnitude of the correlation.[52] Thirty studies failed to give sufficient details of pre- and post- intervention data to allow effect sizes to be calculated. This presented additional difficulties when attempting to compare the impact of different models of service provision.

Figure 1 about here

A number of studies failed to employ recommended procedures for minimising potential bias, or to report sufficient details of study design to allow the reader to assess the risk of bias. There are several types of bias particularly associated with the assessment of vision rehabilitation interventions, notably the loss of patients to follow up, which is inevitably a problem with longer studies, especially when an elderly population is being evaluated. Loss to follow-up can lead to bias when patients who drop out differ in characteristics from those who return for follow-up. For example, if patients who were dissatisfied with the service are less inclined to return to be reassessed, then there will tend to be a bias towards a more positive reported outcome in the remaining individuals. A number of studies attempted to address this problem by comparing all available characteristics of those who did and those who did not complete the study, and by reporting reasons for loss to follow-up.[29,70,108,149]

Another source of bias encountered was the way in which outcome data were collected. There is a risk that patients, particularly after a prolonged rehabilitation training period with a particular

provider will be inclined to report more positively on outcomes if questionnaire items are presented by this provider.[55,73,110] Individuals collecting outcome data should be independent of the service providing team and be 'masked' to the intervention group. Eklund et al commented on the difficulties involved in preventing patients from divulging the nature of their treatment in the follow up interview, even when there is an intention to mask.[49] Asking patients to retrospectively rate their change in function at some point after the completion of the rehabilitation program, without collecting baseline data, can also be a source of bias. The problem inherent in relying on patient memory is evidenced in the study by Walter et al,[155] who conducted a telephone interview approximately 1 year after the conclusion of rehabilitation to ask about change in rated difficulty of activities of daily living from pre- to post- intervention. Of 417 respondents, 105 were unaware of even having participated in visual rehabilitation.

A further potential concern in evaluating these studies is the number of comparisons made. The outcome measures are often questionnaires made up of a number of items, grouped into several subscales. Many studies evaluated pre- to post- intervention data on 10 or more items, with no mention of correction to minimise the risk of a type I statistical error caused by multiple comparisons. If significance is taken at a P=0.05 level, then 5% of comparisons made would be expected to show a significant difference due to chance alone. Two studies addressed this issue directly, using a Bonferroni correction.[10,126,144]

The study that we found to have the least potential for bias in this review is the 2008 LOVIT report.[143] This RCT included a waiting list control, full details of randomisation and masking (with a specified protocol for avoiding the disclosure by patients of their intervention group), the use of a range of well-validated outcome measures, and full details of results. It may be that the publication of this report, and others with a similarly rigorous protocol development (Girdler et al[60]; Reeves et al[115]), marks a shift towards greater consideration of experimental design in future assessment of low vision service provision.

IV. Evidence Synthesis

A summary table outlines the characteristics and outcomes of included studies (Table 2). We will now consider the key findings of the literature, with a view to the quality of the evidence provided. In this review we use the terms: 'very good evidence' when referring to the results of well designed RCTs; 'good evidence' when referring to consistent results from at least two robust studies that are not RCTs and 'evidence' when referring to the results from at least one robust study.

A. EFFECT OF LOW VISION SERVICE INTERVENTION ON CLINICAL MEASURES OF VISUAL FUNCTION

There is very good evidence that the provision of low vision services results in an improved level of clinically measured visual function, particularly with respect to aspects of reading ability.[32,61,69,100,102,107,108,116,126,154] On a basic level, there is good evidence to suggest that LVA provision is an effective means of improving reading ability in patients with visual impairment, although this is often evidenced by an improvement in clinically measured function, rather than by assessment of effectiveness in improving performance outside the testing room.[69,100,154]

Nilsson showed that clinically measured improvements in functional ability can be long-lasting. That is, they evaluated clinical outcomes (distance and near VA) after vision rehabilitation in 76 patients with diabetic retinopathy over a mean follow-up period of 3.6 years, and in 120 patients with macular degeneration, who were followed-up for a mean period of 5 years.[106,107] In both cases, an intensive series of visits incorporating LVA provision and training in use of residual vision was followed-up by extra appointments in subsequent years. Large effects on distance and near acuity were found after the initial set of visits and throughout follow-ups and, even allowing for worsening of disease status, there was a large positive effect size from baseline to the end of the final series of visits. Some caution should be employed when considering effect sizes in the case of improved visual acuity resulting from the prescription of magnifiers. An increase in magnification will result in improved acuity, and so an increased effect size. Clinically, however, high powered magnifiers are often not prescribed as the result of problems with shorter focal lengths and reduced field of view.

Other studies have gone beyond the assessment of change in near acuity, to look at other clinically relevant parameters. For example, Goodrich et al showed a marked improvement in reading speed (effect size 1.01) after a comprehensive inpatient reading rehabilitation programme.[61] McCabe et al measured functional outcomes both clinically (using the Functional Visual Performance test - FVPT) and by self-report (using the Functional Assessment Test - FAQ), and found an improvement in both measures; the mean FAQ scores improved by approximately 10%, whilst the FVPT improved by approximately 50%.[102]

B. FREQUENCY OF USE OF LVAS FOLLOWING LOW VISION SERVICE INTERVENTION AND SATISFACTION WITH LVAS AND SERVICE

There is very good evidence to support the hypothesis that patients value and use low vision aids provided by rehabilitation services.[33,69,70,115,121,122,124] Validity of low vision aid usage as a surrogate for service effectiveness is supported by the findings of Horowitz et al, who reported that the use of LVAs is associated with a reduction in disability and depression at 6 months.[72] The Manchester Low Vision Questionnaire (MLVQ) has been used as a standardised tool to assess aspects of LVA usage and satisfaction.[70,115,122,124] For example, Reeves et al used the MLVQ as an outcome measure

in following up 226 patients for up to 1 year after provision of 3 different service models, and showed that patients valued their LVAs highly, and showed a high use of LVAs throughout the trial, despite apparently negative outcomes in vision-related QoL and QoL domains.[115] In a recent study evaluating the newly established Welsh Low Vision Service, Ryan et al. reported that of 279 service users who returned follow-up questionnaires at 3 months after initial service provision, 92% of those prescribed magnifiers had used them during the past week, and 98% had found the service useful.[124]

C. EFFECT OF REHABILITATION ON VISUAL FUNCTION AND ACTIVITIES OF DAILY LIVING (ADLS)

Studies included in this review have assessed patients' ability to carry out normal activities of daily living from a variety of perspectives (see Table 1). Outcomes have included participation levels in ADLs,[60] confidence in performance of ADLs,[116] dependence or independence in performing ADLs,[48] activity levels,[102] and perceived security/insecurity in performing ADLs,[41,49] as well as assessing basic ability in performance.[55,66,68,72,75,104,110,118,129,137,138,143,144] Despite the disparity in evaluation tools used, there is very good evidence that low vision service provision improves functional ability.

In the only waiting list controlled RCT reviewed, Stelmack et al showed a large improvement in visual function (using the VA LV VFQ-48) as a result of a Veteran's Affairs interdisciplinary outpatient intervention.[143] The largest effect size was found in the reading domain (i.e. from baseline to 4 months Cohen's d, adjusted for control group deterioration = 2.51). Large effect sizes were also seen in visual information processing (2.03), visual motor skills (1.82), mobility (1.14) and overall visual ability (2.51). The waiting list control group showed a small decline in all aspects of function over the 4 months (overall visual function effect size -0.2). Previous studies by Stelmack et al, looking at the effectiveness of other Veterans' Affairs service models, have similarly found a marked functional improvement post-intervention using the VA LV VFQ-48 tool.[138,141] Stelmack et al demonstrated that the positive effects of an intensive inpatient Veteran's Affairs rehabilitation programme on functional ability were reduced, but still large at 12 months (VA LV VFQ-48 effect sizes were 2.035 and 1.405 at 3 and 12 months respectively; N=95).[138]

The greater effect sizes found in comparison to those reported by studies using vision related quality-of-life tools to assess the same type of Veterans' Affairs low vision service (e.g. [88,137]) suggest that outcome measures targeting visual function may be more sensitive to the benefits of this type of service. Although these findings indicate that the VA LV VFQ-48 outcome measure is sensitive to the effects of the Veterans' Affairs services,[138,141,143] which tend to be intensive, multidisciplinary services whose patient base is almost exclusively male, it is less clear whether

similar effect sizes will be found using this tool to assess the outcomes of other types of service. Some evidence that this may not be the case is provided by Stelmack et al, who reported much smaller effect sizes when the VA LV VFQ-48 was used to assess the effectiveness of less intensive outpatient services (two private clinics and two Veterans' Affairs services).[141]

In contrast to the studies using self-report outcome measures, Stephens et al looked at the clinician-rated Independent Living Pre-Programme assessment and Post-Programme assessment outcomes of low vision service provision (across 6 services, providing 4 different models of intervention) in a large sample of 1194 people,[144] and found a significant pre- to post- rehabilitation improvement for all age groups studied (over 65 yrs) in all 4 parameters, with medium effect sizes for all ages. The potential bias introduced by using a clinician-rated measure of functional outcomes was investigated by McKnight and Babcock-Parziale, who compared the change in the Functional Assessment of Self-Reliance in Tasks (FAST) clinician-rated and self-rated scores between a pre- and post-rehabilitation assessment on the basis of complete data from 81 individuals.[104] Their Rasch analysis suggested that the tool gives equivalent results when administered as a self-report tool and when clinician rated. The absence, however, of a statistical difference between the self report and clinician rated scales is not the same as evidence of no difference.

In a well designed 2 arm RCT, Girdler et al compared outcomes from 'usual care' and 'usual care plus a vision self management programme'.[60] The latter intervention involved an 8 week (24 hour) programme delivered in a group environment with 6 to 10 participants. Seventy-seven subjects were randomised and outcomes from a 12 week follow up were reported. The intention to treat analysis showed that the extended model produced significantly improved participation levels and the belief in the ability to manage every day tasks.[60]

Other studies have evaluated the effects of more specialised services. For example, Engel et al and Kuyk et al demonstrated significant improvements in mobility-related ADLs after specific orientation and mobility training programmes, although it was not possible to calculate effect sizes from the data presented.[52,87] Horowitz et al reported small to medium effect sizes for functional outcomes in a large group of participants (N=395) after completion of a group based 'Adaptive Skills Training Programme'.[73] Farish and Wen found large effect sizes, particularly for near work, daily living skills and communication skills, in their evaluation of outcomes of 57 older people undergoing another new service, the "Independent Living Services Programme" for older persons in Mississippi.[55]

Despite the diverse service models evaluated, the variety of different follow-up times and outcome measures used, it is evident that most studies found a significant improvement in functional ability after intervention.

D. EFFECT OF REHABILITATION ON VISION-RELATED QUALITY OF LIFE

There is not a clear distinction between the effects of low vision service provision on self-reported 'visual function' and on 'vision-related quality-of-life'. Many 'vision related quality-of-life' tools employ subsections which address functional deficits, and when outcome measures are reported in terms of overall score on such tools, it is not always possible to determine whether the improvement has actually been mainly in the functional domains. Where possible, this distinction has been clarified.

De Boer et al looked at the change in vision related QoL 1 year after participation in optometric and multidisciplinary rehabilitation services, using the outcome measures Vision Quality-of-life Core Measure (VCM1) and the Low Vision Quality-of-life Questionnaire (LVQOL).[43] VCM1 is a vision related QoL tool that does stand apart from the functional questionnaires, with items addressing more holistic aspects of life satisfaction, including factors such as embarrassment, anger, depression, loneliness and fear of deterioration in vision. The LVQOL tool has a strong functional element, with subsections addressing general vision, mobility and lighting issues, psychological adjustment, reading and fine work, and activities of daily living. De Boer et al found a small but statistically significant improvement in VCM1 scores from pre-rehabilitation to 12 month follow-up (small effect size of 0.132), but no statistically significant difference in LVQOL (deteriorated by effect size of -0.17). They reported that a large number of patients (27% of the 296 who enrolled at baseline) were lost to follow up. Reeves et al also used the VCM1 to assess vision-related QoL outcomes following low vision rehabilitation in a well designed RCT, where participants were assigned to 1 of 3 different modes of rehabilitation.[115] They similarly found a lack of improvement at 12 months, and actually reported a small but statistically significant decline in vision-related QoL in all groups. Neither of these studies incorporated an untreated control group, and it might be hypothesised that the lack of positive effect could be attributable to the decline in baseline function over the course of the year. To investigate this, van Nispen et al reanalysed the data of de Boer et al to include a 5 month follow-up analysis, and found that there was little improvement from baseline, apart from in the 'reading small print' item.[43,149] Wolffsohn et al also found the reading and fine work subscale of the LVQOL to show the greatest improvement at a 1 month follow-up of 278 individuals undergoing multidisciplinary low vision care (effect size 0.28).[160] As in the LOVIT study of Stelmack et al, the ability to perform near tasks appears to be most sensitive to rehabilitation.[143]

The NEI-VFQ 51 and 25 item questionnaires[98] have also been widely used in assessing the effectiveness of low vision intervention, and were employed by a number of studies in this review.[88,89,92,126,129,137,140] Both versions of the tool contain functional and more general QoL

subscales. Kuyk et al showed a moderate increase in vision-related QoL (NEI-VFQ 25) after a very intensive inpatient service treating male veterans who were legally blind.[88] The composite score effect size was 0.59 and 0.55 at 2 and 6 months follow-up respectively. The near vision subscale effect size was greatest (1.49 and 1.44 effect size at 2 and 6 months respectively). The distance vision subscale was also markedly improved (0.68 and 0.56). Other subscales showed smaller improvements; the general health subscale was the only one to show a decrease. The Veterans' Affairs services tend to be more intensive than standard low vision services, and this is reflected in the effect sizes reported. For example, Scott et al assessed outcomes in 156 patients after a 60-90 minute intervention.[129] They showed a significant improvement in NEI-VFQ 51 item score (outcomes assessed 3 months after treatment), but only in general vision, near activities, distance and peripheral vision subscales (effect sizes: general vision: 0.34, near activities: 0.59, distance activities: 0.21, peripheral vision: 0.33). La Grow et al used the NEI-VFQ 25 and the "Measure of Functional and Psychosocial Outcomes of Blind Rehabilitation" to assess outcomes of integrated and standard low vision service models at 6 months and 1 year.[89] Outcomes from both services showed no significant change from baseline to the 1 year follow-up. A novel 7-item version of the NEI-VFQ, designed to target those aspects of visual disability which have been shown to be amenable to modification by low vision service provision[123,143] was used in a recent evaluation of a new community-based low vision service.[33,124] There was a significant reduction in visual disability between baseline and 3 months for both those in the community-based low vision service (n=343) and those in a hospital-based low vision service (n=145).

Although a number of studies have demonstrated significant improvements in 'vision related quality-of-life' following rehabilitation, it is the items related to functional measures (particularly near vision), rather than less specific aspects of health-related QoL, that show the greatest sensitivity to the intervention.

E. EFFECT OF REHABILITATION ON MOOD

Preceding sections have demonstrated that functional ability improves following rehabilitation. Given that there is evidence to suggest that mood and psychological status are connected closely with the ability to perform daily tasks,[54] an improvement in psychological status might be an expected consequence of low vision service provision, even in the absence of a specific counselling/psychological component. However, section D on the effectiveness of low vision service intervention on vision related QoL indicated that functional items tended to be more sensitive to rehabilitative intervention than psychosocial type items in most questionnaires. Similarly, in studies which have used tools designed specifically to detect changes in psychological

status, the results have also been less encouraging than the outcomes regarding functional status.[5,41,44,45,48,49,60,72,73,75,76,105,109,110,116,139]

There is very good evidence that the Veterans Affairs outpatient program does not reduce the symptoms of depression. Stelmack et al found no improvement in self-reported symptoms of depression using the Centre for Epidemiological Studies Depression Scale (CES-D) at the 4 month follow up, even after a high dose intervention (Veterans' Affairs outpatient service) which showed large improvements in visual function.[143] However, that service did not contain a specific counselling or psychological intervention. Horowitz et al found a very small positive effect following low vision service intervention at variable settings in New York on CES-D outcomes (effect size -0.045, indicating a reduced level of depression) at a 20-27 month follow up,[76,77] although the lack of a control group may have resulted in an underestimation of the effect of the service. The service was variable in its structure, and could include counselling as one component, although analysis indicated that utilising the counselling service was not associated with fewer depressive symptoms at follow-up. In another trial, with a shorter follow-up period of 6 months, Horowitz et al found a larger, although still small, improvement in depressive symptoms (effect size -0.11) using the CES-D, even though there was an overall increase in functional disability (effect size 0.05).[72] Robbins and McMurry evaluated depression outcomes of 57 individuals at the Kooyong Low Vision Clinic (a multidisciplinary service, without any specified counselling or psychological service), using the Geriatric Depression Scale (GDS-30).[116] There was a small to moderate reduction in depression, but this change was not statistically significant.

More positively, there is very good evidence that the addition of a 'vision self management programme' can produce a small reduction in depressive symptoms. Girdler et al evaluated the outcomes of a 'vision self-management programme' compared to 'usual care' in 77 individuals with visual impairment (N=36 received the self-management training), and reported that those in the self-management programme had significantly fewer depressive symptoms (GDS) at 12 weeks than those in the standard visual rehabilitation service (effect size 0.18).[60] Horowitz et al found a significant improvement in the Adaptation to Age-Related Visual Loss (AVL) scale (medium effect size 0.42) in 395 individuals undergoing an "Adaptive Skills Training" programme, although outcomes were assessed immediately after the service in person by the service provider and there was no control group, which does introduce a potential for bias.[73]

Needham et al evaluated the effectiveness of an inpatient Veteran's Affairs 3 month adjustment to blindness programme on 80 patients (all male), of whom approximately half had a psychological disorder. Intensive psychological treatment was available to patients during their stay. After the first week, and at the end of the programme, subjects were graded by staff on a 5-point scale in terms of

ability, attitude, and overall adjustment.[105] Medium effect sizes were found for all parameters, in those with and without a psychological disorder. However, these results should be treated with caution because of the risk of observer bias. Bernbaum et al found comparable effect sizes after intensive low vision rehabilitation (including individual counselling) for patients (N=29) with visual impairment from diabetic retinopathy.[5] At the end of the 12 week programme, they found a small improvement in the Zung score (effect size 0.24) for people with a stable visual state, and a medium effect size for people with transitional visual loss (effect size 0.59, P=0.06). Those said to have "transitional visual loss" generally had fluctuating vision, and were undergoing active medical intervention. There was also a significant medium effect size in self-esteem for both types of visual status (effect sizes: stable visual state = 0.49, transitional visual loss = 0.56). These results should also be treated with caution as the sample size was small.

F. EFFECT OF REHABILITATION ON GENERIC HEALTH-RELATED QUALITY-OF-LIFE

The majority of studies reviewed showed generic health related quality-of-life measures to be insensitive to low vision rehabilitation. For example, Stelmack et al found no improvement in QoL (SF-36) even after a high dose intervention that showed large improvements in visual function.[143] Lamoureux found no change in SF-12 at a 3-6 month follow up after multidisciplinary service provision,[91] while Reeves et al showed a deterioration in SF-36 scores at 1 year follow-up.[115] Similarly, Scott et al found that a basic low vision service (60-90 min visit) had no significant effect on general health related QoL assessed using the SF-36.[129] La Grow et al used a single item QoL measure in their comparison of integrated and standard low vision service models, and also found no change at the 6 month or 1 year follow up periods.[89]

A few studies have reported improvements in health related QoL. For example, Girdler et al provides very good evidence in support of a small improvement in the physical and mental component summary of the SF-36,[60] with the physical component summary showing significantly greater improvement in the group undergoing the vision-self management programme than in those receiving 'usual care' (effect size 0.23 at 3 month follow-up). Kuyk et al used the SF-12 at 2 and 6 months after an intensive inpatient program[88] and reported a significant improvement in the mental component summary (effect size 0.17), but a significant reduction in the physical component summary (-0.24).

One study which found large positive results using a general QoL tool had a very different setting and patient demographic to the other included studies. Vijaykumar et al evaluated the impact of a community based rehabilitation programme on the QoL of 159 individuals in rural India who had "no useful residual vision" (VA<1/60).[151] The 12-item instrument included largely activities of

daily living, consisting of self-care, mobility, social and mental subscales. There was a marked improvement, especially in self-care and mobility subsections, but all effect sizes were very large (above 1), although the method of effect size calculation was unclear. The authors commented that the areas of improvement may have reflected the emphasis placed on physical rehabilitation in a rural setting. Details of the rehabilitation were not given, but the demographic of the patients was markedly different from most other studies, e.g. mean age 45 years. Some caution is needed because the 'general QoL' instrument used in this study included many 'activities of daily living'.

G. THE DIFFERENTIAL EFFECT OF LOW VISION SERVICE MODELS.

Unfortunately, it was not possible to assess the relative benefits of different service models across studies because of the use of different outcome measures, follow-up times and diverse populations studied. However, several studies evaluated the effectiveness of different service models side by side, either in RCTs,[115] or at least using the same outcome measures.[41,43,48,49,60,102,115,141,149]

Several studies have looked at the differential effect of optometric and multidisciplinary service models and found little difference in outcomes.[43,89,115,149] Reeves et al conducted an RCT to compare the effectiveness of three different models for low vision service provision.[115] The first arm involved a standard optometric low vision assessment; the second intervention arm included the same optometric low vision assessment plus a home-based rehabilitative intervention at 2 weeks, 4-8 weeks, and 4-6 months; the third arm included the optometric intervention plus supplementary home visits by a community care worker with no formal training in low vision. Outcome measures were obtained at 12 months and included the vision-related quality-of-life tool VCM1, the Manchester Low Vision Questionnaire (MLVQ), and the Nottingham Adjustment Scale (NAS). No significant benefits were observed for the enhanced services for any of the outcomes measured (A few significant differences tended to favor the standard service and were attributed to type I errors.).[115]

De Boer et al compared the outcomes of an optometric service with those of a multidisciplinary service in the Netherlands in a controlled before and after study (patients allocated according to geographic location) using VCM1 and LVQOL vision-related QoL outcomes measured at 1 year post-intervention.[43] There was a marked difference in the components of the two services. The optometric service provided advice about which low vision aids to use and how to use them, with low vision aids being ordered where appropriate, while the multidisciplinary service included the above as well as training in activities of daily life by an occupational therapist, group or individual counselling by a social worker/psychologist, and advice on adaptation of home environment where required. Both services included follow-up appointments as required. This was a large study (N=296), but no significant difference was seen between the service models except for mobility

subscale of LVQOL, which was better in the optometric group (although the authors attribute this difference to possible type 1 errors due to multiple comparisons or to differences in baseline mobility between groups). Van Nispen et al reanalysed these data using item response theory and concluded that neither of the services contributed to improving vision related QoL, except for reading small print.[149]

La Grow et al similarly reported no significant difference between NEI-VFQ 25 outcomes at 6 and 12 months between individuals undergoing a comprehensive (N=93) and a standard (N=93) low vision service in New Zealand in a controlled before and after study.[89]

Stelmack et al used the VA LV VFQ-48 to assess the outcomes of an inpatient (Veterans' Affairs intensive service) and outpatient service (provision of LVAs, low vision evaluation, training in LVA use and 2-4 therapy sessions) and found an effect size of 2.1 for the inpatient service but only 0.26 for the outpatient service.[141] They commented, however, that the inpatient participants had a much lower level of visual function at baseline and therefore had more scope for greater improvement through rehabilitation. There was also a significant gender difference between the participants (inpatient 93% male; outpatient 62% male).

In an RCT, Dahlin Ivanoff and Eklund et al compared a 'health education programme' (an 8 week group-based programme using problem solving therapy) with an 'individual intervention'.[41,48,49] At 4 months, the group undertaking the health education program (N=93) showed an improvement in perceived security in 22 out of 28 ADLs, while those undertaking the individual optometric intervention (N=94) improved in only 5 of 28 ADLs.[41] At 28 months, the health education group (N=62) retained a significantly improved level of security in 20 ADLs compared to baseline, while the individual intervention group (N=69) showed a significant change towards decreased security in 12 ADLs.[49] The individual intervention group also showed a significant decrease in independence over the 28 month follow-up period, while the health education group did not.[48] Similarly, there was a greater reduction in general health score in the individual intervention group, as assessed by 1 item from the SF-36. The health education group appeared to have a more positive attitude towards their state of health, reporting fewer health conditions.[48] It should be noted that the novel analytical methods used by Dahlin-Ivanoff et al and Eklund et al preclude direct comparison with other studies; however, the functional outcome measures used were clearly sensitive to the interventions.[41,48,49]

Girdler et al provided further evidence in a well-conducted RCT of the positive impact of a group-based programme on rehabilitation outcomes.[60] The 36 participants allocated to the 'usual care + vision self-management' group showed significantly better outcomes at 3 months than those in 'usual care' with respect to participation levels in every day tasks (effect size 0.31), levels of

depression (effect size 0.18), self-efficacy (effect size generalised self-efficacy 0.14; age-related vision loss self-efficacy 0.30), and the SF-36 physical component summary (effect size 0.23). These effect sizes describe the relative effect of the enhanced service.

H. THE EFFECT OF FOLLOW-UP TIMING ON REHABILITATION OUTCOMES

The studies included in this report had follow-up times which ranged from immediately post-intervention to 5 years (median 3 months, interquartile range 0-10.5 months). Figure 2 shows the relationship between effect size and follow-up time for all studies where sufficient data were available. There was no significant relationship between follow-up time and effect size (Spearman's Correlation; P>0.05), which might be attributable to all the other variables which differed between studies (intervention model and dose, patient demographic, outcome measures employed), which may have obscured the impact of follow up time.

Figure 2 about here

The studies that best demonstrate the effect of timing of follow-up are those that sample patient outcome data at a number of time points. Kuyk et al compared outcomes of the intensive Veterans' Affairs inpatients programme at 2 and 6 months post-rehabilitation.[88] A greater improvement in almost all subscales of NEI-VFQ 25 was seen at 2 compared with 6 months, but the difference was small (effect size 0.59 at 2 months and 0.55 at 6 months). Kuyk et al found a larger effect size than Stelmack et al, who also evaluated a Veterans' Affairs inpatients service using the same outcome measure, but followed up immediately after the end of rehabilitation. Kuyk et al suggested that this discrepancy in outcome could be attributable to the difference in follow-up time and postulated that the full effect of treatment will not be apparent until patients have had the opportunity to use their new skills in their home environment.[88,140]

It is generally expected that the outcomes of rehabilitative intervention (particularly in older adults) will decrease over time as the result of a general decline in baseline function.[161] This expectation is perhaps reflected in the lack of positive effects observed in some of the studies that obtained follow-up outcomes after a significant period of time.[43,75,137] Stelmack showed that the beneficial effect of the Veterans' Affairs inpatient programme was maintained, but reduced, at 12 months post-service (LV VFQ 48 effect sizes were 2.035 and 1.405 at 3 and 12 months respectively).[138] However, Stelmack et al followed up patients from the Hines Veterans' Affairs rehabilitation centre after 3 years[137] and found that the improvement in visual ability seen at the conclusion of the service did not persist over this follow-up period. Horowitz et al followed up 155 patients at 20-27 months after provision of a vision rehabilitation service, and only found a very small effect size (0.045) in terms of reducing psychological symptoms of depression.[75]

An RCT investigating the outcomes of a "problem solving" group health education program at 4 months and 28 months was unusual in showing a positive effect which continued for more than 2 years.[41,48,49] The positive effect of the health education programme in perceived security in ADL was undiminished at 28 months, possibly because the "problem solving skills" acquired allowed participants to meet new challenges as they developed further visual problems. It should be noted, however, that 42% of participants (98 of 229) randomised at baseline were lost to follow-up over 2 years. Other parameters were maintained less well: there was a trend towards a decrease in independence in ADL over 28 months, but this finding was not statistically significant, whilst general health (one item from the general health-related QoL questionnaire SF-36) decreased significantly over 28 months.

None of the studies have presented evidence for a halo effect (i.e. a peak in outcome effect at very early times post service). Future work should obtain outcome data at regular intervals to chart more precisely the change in effect that occurs as a function of follow up time and compare to a control group.

I. THE EFFECT OF REHABILITION "DOSE" ON OUTCOMES

The studies included in this review have used service models which differ widely both in terms of "content" and "dose". Many of the studies reviewed do not detail the number of hours of rehabilitation provided, but a median of 24 hours (interquartile range 5.8-72 hours) was calculated from the 20 services that allow an estimation of dose (this included any hours of homework specified). The value is skewed towards a large intervention dose as the intensive Veterans' Affairs inpatient services, lasting around 40 days have been involved in a number of the included studies (they include a 'dose' of approximately 210 hours, on the basis of 7 instruction periods per day, each lasting for 45 minutes[88]).

Figure 3 plots the relationship between dose and effect size for the 11 studies that provided sufficient information to calculate both parameters. There was a significant correlation between dose and effect size (Spearman's correlation coefficient=0.48; P=0.04), and it can be seen that, generally, those services that provided a very high level of intervention showed medium or large effect sizes. It should also be noted that the 'dose' has been plotted for the intervention as a whole, not broken down into the different components of the service. It is possible that a stronger relationship may be seen between the intensity of a particular element of the service and specific outcomes pertaining to that aspect of rehabilitation.

Figure 3 about here

Very large effect sizes have been reported for the high intensity Veterans' Affairs outpatient service in the LOVIT trial (10 hours clinical contact and 17 hours homework)[143] and for other high-intensity services.[138,141] Several studies, however, reported a medium to large effect size without such an intensive inpatient intervention.. Goodrich et al provided a mean intervention of 6.67 hours, and achieved an effect size of 1.01.[61] Scott et al also showed medium effect sizes in NEI-VFQ 51 (0.59, near vision subscale) and VF-14 (0.42), although only 1-1.5 hours of service were provided (including training) with no follow up.[129] The mean number of devices provided was high (3.4 per person), which may explain the specific improvement in near function.

A confounding factor in the comparison of the dose-effect size relationship in different studies is introduced by the different levels of training that are likely to be required to achieve a positive effect in different aspects of rehabilitation. For example, a larger 'dose' of orientation and mobility training is likely to be required to result in an improved self-reported function than that required to achieve a large improvement in clinically measured function with a magnifier (e.g. reading acuity). Furthermore, studies differed in follow-up timing and outcome measures used, as well as in hours of intervention, complicating the analysis of any relationship between dose and effect size in different reports.

Several studies did directly evaluate the effect of service dose.[52,72,126,141] Horowitz et al assessed functional and psychological outcomes at 6 months post-rehabilitation and found that change in visual disability over time was not associated with number of rehabilitation service hours after accounting for the level of disability at baseline (patients received a mean of 5.8 service hours, SD 7.9).[72] The intervention was provided at various community rehabilitation centres, however, and it is not clear whether the hours of service provided were determined by patient needs or by the protocols of different service models within the study. Engel et al looked at effect of dose of an orientation and mobility program on outcomes including performance of ADLs, physical health and mental health.[52] They found that an increased number of rehabilitative sessions were significantly correlated with fewer days in bed, fewer talks with doctors, less difficulty taking medicines, increased frequency of hobbies and activities, whilst increased hours of intervention were related to fewer talks with doctors, less difficulty with walking, increased hobby activity, and increased moderate physical activity. The details of the magnitude of the correlations and the P-values are not provided in the paper. Stelmack et al found a very large effect using the VFQ 48 following an intensive inpatient Veterans' Affairs rehabilitation programme (42 days) but only a small effect following assessment of less intensive outpatient programmes at 4 clinics (2-4 visits), two of which were Veteran's Affairs services and the remaining two private clinics.[141]

Despite the conflicting evidence, overall it seems that the larger effects reported in the literature tend to come from intensive rehabilitation programmes e.g. [87,143], although other studies have shown that it is possible to obtain a medium or large effect size with a relatively low dose intervention.[61,144]

J. THE EFFECT OF REHABILITATION ON OUTCOMES IN CHILDREN

The vast majority of the services included in this review were principally concerned with the rehabilitation of elderly adults with visual impairment. Our literature search indicates that there are currently no rigorous studies of interventions relevant to children. Corn et al measured reading rates and comprehension in children (N=130) before and after issue of LVAs (optical magnifiers) and showed a significant improvement in silent reading speed and comprehension (but, interestingly, not in oral reading speed or comprehension).[32] The authors did not control for an improvement with time. Their subjects had at least four months of magnifier use, which may have been long enough for a natural improvement in reading skills.

In a descriptive study Ruddock et al selected 57 children who were either in a school with a resource base for those with a visual impairment, or in mainstream school, but considered by teachers to have problems accessing near tasks.[121] Of these children, fourteen had LVAs, and only 3 used them regularly. Once an integrated low vision scheme was set-up and 32 children assessed, 29 were given LVAs, and of these, 25 were making regular use of aids at review.

The paucity of information relating to children indicates that there is an urgent need for properly conducted studies. Part of the reason for the dearth of studies may be that, until recently, valid outcome measures have not been available for children. Most QoL questionnaires for children have been developed from, or include, opinions and experience of caregivers and/or experts rather than from the direct responses of children.[8,27,62] More recently, focus group work with children and Rasch analysis have been used to develop an outcome measure of direct relevance to the lives of children but it has not yet been used to evaluate service provision.[84] There are other practical barriers which hinder the assessment of vision rehabilitation in children, including the relatively low prevalence of visual impairment in this age group[113] and the numerous causes of visual impairment in children, which often form part of wider conditions or disabilities, making this a difficult group to research.[12]

K. THE COST-EFFECTIVENESS OF LOW VISION SERVICE PROVISION

We also tried to explore evidence of the cost effectiveness of low vision service provision. Only two studies met the criteria for inclusion in the review: The single centre RCT set in Sweden, reported by Eklund et al and a cost consequences evaluation of an outpatient (OP) rehabilitation

programme compared with residential rehabilitation for legally blind American Veterans reported by Stroupe et al.[50,145]

The single centre RCT set in Sweden, reported by Eklund et al, compared the cost-effectiveness of a group "Health Education Programme" delivered to groups of 4-6 people with AMD, to 'usual care' using an individually designed programme.[50] The 8 week program of weekly 2-hour sessions led by a specially trained occupational therapist cost SEK (Swedish Krona) 6558 (£630) per person. Usual care at the low vision clinic cost SEK 5907 (£567) per person. When calculating the total costs for each service (SEK 28,004 [£2688] and SEK 36,341 [£3488] for the health education and usual care services respectively) the clinical costs were added to external costs that resulted from aspects such as ophthalmological care, home care, and housing adaptations. Differences in costs between the two groups were not statistically significant; however, at 28 months there was a statistically significant difference in cases showing an improved level of 'security' (45% vs. 10%) between those in the health education programme and those receiving usual care. When looking at the total cost per improved case (i.e. including external costs) the average cost for the "Health Education Programme" was SEK 62,010 [£5,955] compared with SEK 358,216 [£34,399] for usual care. Incremental cost effectiveness ratios were not calculated.

Stroupe et al evaluated the short term cost consequences of an outpatient (OP) rehabilitation programme compared with residential rehabilitation for legally blind American veterans.[145] The program was designed to improve functional ability as measured by Veterans' Affairs LV VFQ-48, and changes in performing everyday tasks. Follow up was at 3-4 months. Both inpatient and outpatient groups showed significant improvement in overall visual ability, mobility, and visual motor skill at 3 or 4 month follow-up. When adjusted for baseline differences in LV VFQ-48 score, age and gender using linear regression analysis, the inpatient group showed significant improvement over the outpatient group. The costs for the inpatient group were higher, per inpatient the cost was US$43,682 [£23,795] (SD US$8,854 [£4,823]) compared with the mean outpatient cost of US$5,054 [£2,753] (SD US$405 [£221]); difference US$38,627.3 [£21,040] (95%CI: US$17,414-US$273,482). Again, incremental cost effectiveness ratios were not calculated.

There were methodological problems with both studies.[50,145] Full details of unit costs were not given in either paper and it was unclear whether all relevant costs had been included. The RCT reported by Ekland et al[50] did not detail randomisation methods and had a high drop-out rate. The study reported by Stroupe et al compared treatment groups from 2 different trials; thus, it is possible that there were differences between the groups impacting on the outcomes.[145]

V. Future studies

A. STUDY DESIGN CONSIDERATIONS

One of our major findings is that the number of high quality research studies on the outcomes of low vision service provision is pitifully small. Of the 478 potentially relevant articles, only 58 met our liberal inclusion /exclusion criteria, and of these only 7 report the outcomes of randomised controlled trials. Higher quality visual rehabilitation research studies are needed and consensus amongst professionals and patients is required on a core outcome set to be assessed by such research. Whatever research is to follow should be well designed, conducted, and reported, and there are now excellent reporting standards available to interested researchers on different types of study design.[F]

Randomised controlled trials are considered to provide the highest quality evidence and we believe should be the design of choice. The CONSORT group provide useful guidance on the design and reporting of randomised controlled trials.[127] Well designed cohort studies (e.g. prospective controlled before and after studies) can also provide robust estimates of treatment effect, frequently providing results comparable to RCTs [30] and often giving results that are more easily generalisable. These reporting standards have been developed with particular thought being given to potential sources of bias for study findings. There may be selection bias (Patients who take part in studies are not representative of those as a whole.), selective outcome reporting bias (Only outcomes found to be statistically significant are published.), follow-up bias (Only patients in whom treatment is working stay to the end of the study.). These reporting standards also give guidance on other important design issues such as masking and sample size. Masking (more commonly termed "blinding" – except in studies on vision, for obvious reasons) is where the treatment allocation is not revealed to patients, physicians, and or outcome assessors. Although masking participants in a rehabilitation setting can be problematic (unless a 'sham' treatment is included), masking the person collecting the outcome data is usually possible (see Stelmack et al[143]) and at the least, masking violations can be recorded. Masking the person collecting the data is desirable because it removes the possibility of observer bias, i.e. where the researcher's cognitive bias may unconsciously influence the participant's responses. Outcomes should not be collected by the person providing the rehabilitation intervention, as otherwise there is the real risk that positive outcomes are due to the participant trying to please the person involved in providing their clinical care.

Importantly, both RCTs and cohort study designs typically include a control group; that is, a group of people who exemplify what normally happens as a result of no treatment or treatment as usual. The use of a control group is a major strength because it enables greater confidence that observed outcomes in the experimental group are dependent on the intervention studied and not some other factor, e.g. advancing pathology or a visit to a friendly clinic. The quality of future low vision

rehabilitation studies could be significantly improved with the inclusion of a control group, although the ethical issues of denying or delaying treatment should be considered.

The factors discussed above may all be sources of bias in both randomised and non-randomised study designs. Additional selection bias in the non-randomised trials is conferred by potential differences in the characteristics of the participants in the different arms of the study, depending on how allocation occurs. For example, a study comparing outcomes between two treatment modalities taking place in different hospitals may have to take account of potential geographic differences in the participants that may have a confounding effect. As a whole range of study designs fall under the umbrella of 'non-randomised studies', there is no generic tool for the assessment of bias in these studies.[G] Certain sources of bias are not applicable to all types of non-randomised trial, for example masking of patients/researchers is not relevant in non-controlled trials.

The size of the sample studied is another important consideration. Studies that are too small are very likely to miss clinically valuable differences but they can also produce statistically significant results because, by chance, the observed difference in the sample is much larger than the real difference. Studies that are too large simply waste resources and can result in delays to implementing new and better treatments. Many studies identified in this review do not present a statistical calculation of the appropriate sample size. Future studies should ensure they have sufficient statistical power to detect clinically important differences at the outset of the study and that such calculations allow for potential loss to follow-up and non compliance.

In summary, future studies should adopt a robust study design, include a control group, masking, and ensure that the trial is sufficiently powered and focus on a consensus driven core outcome data set. Engaging the services of a statistician and a health economist early in the study design stage is highly recommended.

B. FUTURE RESEARCH AGENDA

An important step forward would be for the research community to reach a consensus on the most appropriate core outcome measures to use. Table 1 shows that at least 40 different questionnaires have been used as outcome measures, many of these being developed in the last 10 years. The development of appropriate, validated and sensitive outcome measures has been an important goal, [101] but the continuing use of such a diverse range of instruments prevents direct comparisons of effectiveness and cost effectiveness being made and ultimately hinders the identification of services that may be beneficial.

Although most recent studies employ self-rating scales of some type, the design of these scales, which items they include, and how the data are analysed varies considerably. Item response theory

(IRT), including Rasch analysis, was employed by some of the studies in this report.[91,102,104,137,138,140,141,143,149] This approach aids both questionnaire development and outcome measurement. Development is improved by item response theory because it can provide information about the ability of each question to measure the underlying trait i.e. "misfitting" items can be removed. In this way IRT can contribute to the development of highly focused questionnaires that measure a single latent trait. Outcome measurement is also improved because IRT generates scores on an interval scale, unlike the classic Likert scales,[42] and it has been suggested to provide a more robust approach to the interpretation of rating scales.[134] The choice of items in any self-rated outcome measure is also of great importance – a positive effect will only be found if the items included are responsive to the treatment.[140] In future, the development and rigorous validation of scientifically sound outcome measures must be a high priority of the field and a major criterion for judging the quality of a study.

Significantly more high quality research is required to determine what types of rehabilitation service are most effective. Group based rehabilitation components appear to be helpful[39,41,48,49,60] but what can other components contribute to positive patient outcomes e.g. homework, 'counselling for all', 'gadgets', 'a home based assessment' etc?

What interventions are most appropriate for specific groups of people with impaired sight? For example, estimates suggest that about 1/3 of people receiving low vision rehabilitation have significant depressive symptoms,[77] but what types of intervention are most appropriate in this group? Many outcome studies have concentrated on adults over retirement age. What services are helpful to those of working age? Does low vision service provision improve outcomes that matter to children?

Vision rehabilitation services often have to compete for funding with other health care services. Robust health economic data is required to support continued investment in these services. We found little evidence of economic evaluations of low vision services or rehabilitation. Key challenges for service provision will be the increased number of service users as a result of demographic changes in an ageing population at a time of financial constraint. A randomised controlled trial with integrated economic analysis is needed to investigate the ability of different models of low vision services to deliver an efficient and cost effective service.[47]

VI. Conclusion

Overall, there is a lack of high quality evidence to support the effectiveness or cost effectiveness of low vision service provision. There are only seven randomised controlled trials, and only one

includes a waiting list control. The majority of studies use a relatively weak before and after comparison design. Few studies incorporate a comparison group, and very few control for the underlying deterioration in visual function that may offset any benefits associated with rehabilitation. Many articles fail to provide an adequate description of the intervention studied, and results are not always reported in full. There has been little agreement about how best to measure low vision service outcomes and this lack of consensus frustrates study comparisons.

In summary, the available literature indicates that there is good evidence to show that low vision aids provided by rehabilitation services improve reading ability and are valued by service users.[61,69,70,100,107,108,115] There is very good evidence that Veterans' Affairs rehabilitation programs (both inpatient and outpatient) have a very large positive effect on self reported functional ability.[138,141,143] There is also evidence that other rehabilitation programmes have a medium to large effect on functional ability.[66,144] There is little evidence that low vision services improve generic health related quality of life[88,89,91,109,115,129] except for services that include a group based component.[60] The evidence about the ability of services to improve vision related quality of life is contradictory.[43,88,91,115,129,140]

Effect sizes for psychological outcomes have ranged from negligible to moderate. The Veterans' Affairs inpatients program and group intervention models have had the greatest effect.[60,73,105] It is notable that these were high dose interventions, and patients were followed up immediately after the conclusion of the program Bernbaum et al found comparable effect sizes, but only in a small group of patients with transitional visual loss, which may have been due to their poor psychological status at baseline.[5] Despite reports of small improvements in mood or reduction in depression after low vision service intervention,[72,75,76] there is little evidence that an intensive outpatients' rehabilitation programme can reduce depressive symptoms.[143]

There is little evidence that services that include additional home based rehabilitation visits are better than standard hospital based services in the UK.[115] There is little evidence that multidisciplinary services are better at improving vision related quality of life than optometric services in Holland and New Zealand.[43,89] There is good evidence, however, that a group based problem solving health education program is more effective than an individual intervention.[41,48,49] There is also evidence to suggest that there is a greater improvement in self-reported visual function after an inpatients' rehabilitation service compared to an outpatients' program.[141]

It is not yet clear how rehabilitation outcomes change over time. There is some evidence that the benefits are greatest about 2-3 months after the intervention[88,138] and that, over the following year or years the beneficial effects decline.[137,138] Such decline in outcomes over time is not a universal

finding, perhaps because some programs provide people with skills that enable them to adapt to changing circumstances.[41,48,49]

There is some evidence that better outcomes are achieved with more intensive rehabilitation programmes, i.e. a dose effect.[141] However, while larger effects are generally reported following more intensive rehabilitation programs,[138,141,143] this is not always the case.[61,144] The optimum dose of rehabilitation has not yet been established. There is very little information about rehabilitation outcomes in children, in those of working age and in minority groups. What little evidence there is for children only relates to the use of low vision aids and reading ability.[32,121]

There is little information about the cost effectiveness of low vision rehabilitation. Only 2 studies are directly relevant to the cost of low vision rehabilitation,[50,145] and neither included incremental cost effectiveness. Therefore, it is not possible to conclude that the programs studied were cost effective.

Robust research methods and high quality reporting are necessary to advance our understanding of how rehabilitation services can best help people with a visual impairment. It may be useful to observe the approaches taken in determining effectiveness (and cost-effectiveness for more established rehabilitation services, such as stroke rehabilitation[57,119,125]) to provide guidance into the best strategy for obtaining the necessary high-quality evidence regarding the effectiveness of vision rehabilitation.

Although the literature demonstrates that low vision services can help people with a visual impairment, many fundamental questions about the effectiveness of low vision rehabilitation remain. We do not yet fully understand the characteristics of an effective rehabilitation program, including the optimal dose of the service, and the type of service which achieves the best results. The evidence available is not sufficient to make judgements about those individuals who benefit most from a service, and there is a clear lack of data regarding low vision rehabilitation for children. Further research is also required into the cost effectiveness of rehabilitation, an area which is vital in obtaining funding for the development of future services.

VII. Method of Literature Search

The following databases were searched: Web of Science, EMBASE, Medline, Cochrane CENTRAL, Psychinfo, and CRD databases. The search period extended from 1950 (Medline only) to August 2010. The search terms used were divided into 3 categories namely, A) target population (*low vision, vis* impair*, sight impair*, partial* sight*, age-related macular degeneration, age related macular degeneration, central scotoma, hemianopia, tunnel vision, retinitis pigmentosa, visual disability, subnormal vision, low-vision*); B) intervention (*service, rehabilitation, integrated,*

assessment, provision, intervention, training, eccentric viewing, assistive technolog, peripheral prism*, LVES, cognitive skills, psychosocial, psychological, education*, LVA, low vision aid, magnifier, clinic, prescribing, multiprofessional, multi-professional, multi professional, multi-disciplinary, multidisciplinary, multi disciplinary, CCTV, sensory aid*, reading aid*, guide dog*, sensory substitution, mobility training, occupational therapy, activities of daily living, low vision device*); and C) study design / outcomes (*observational, randomised, randomized, audit, effectiveness, outcome*, controlled, quality-of-life, quality-of-life, questionnaire*, self-efficacy, depression, empowerment, evaluation, economic evaluation, economic analysis, cost allocation, cost benefit analysis, cost containment, cost effectiveness analysis, cost minimisation analysis, cost utility analysis, health care costs, health care finance, health economics, social economics, disability adjusted life years, DALY*, QALY*, EuroQol, EQ5D, HUI, quality of wellbeing, SF6, SF12, SF36, survey*). All selected studies were required to match at least 1 search term from each category. Additional literature was identified via hand searching of relevant reviews i.e. Hooper et al[71]; AHRQ report [C]; The Lewin Group [H]; Virgili and Acosta[152]; Stelmack[134]; Stelmack[135], and by asking experts in the field for additional sources of information. The list of references of all identified studies was also checked to ensure that all relevant papers were considered.

Included studies had to involve people with a visual impairment, include a comparison (between groups or over time) and be of a rehabilitation service. Studies were excluded if they: assessed only a specific service component (e.g. reading aids); obtained results from simulated visual impairment; included less than 10 service users; were case studies or abstracts; involved the assessment of surgical procedures (because these are not generally available in a rehabilitation setting); reported the outcomes of 'visual restoration therapy' (because this is a specific intervention rather than 'service'); included participants with multiple disabilities (due to the difficulty of determining the elements due to visual impairment in such complex interventions); were not in English.

The studies included in this review incorporated a range of outcome measures, follow-up times, and interventions and varied greatly in methodology. To aid a qualitative comparison of the outcomes of different studies, effect sizes were calculated where possible, using Cohen's d method (effect size = mean change in outcome parameter/pooled SD at baseline and follow-up). Effect sizes of less than 0.2 were considered small, approximately 0.50 are medium, and above 0.80 are large.[28,91] It should be noted, however that these terms must be used in context – the effectiveness of an intervention can only be interpreted in relation to other interventions that seek to produce the same effect. The practical importance of an effect depends entirely on relative costs and benefits. We opted not to conduct a meta analysis in this review because of the widely varying methodology, outcomes, follow-ups and interventions.

In the economic analysis, an on-line historical currency converter (http://www.x-rates.com/cgi-bin/hlookup.cgi) was employed to convert local currencies used in reviewed studies into pounds sterling (£).

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	Tool	Aspect of function/status assessed	Refs to instrument design	Studies in review using tool
Objective/Clinical Measures	Distance Visual Acuity			48,69,100,106,154
	The Functional Visual Performance Test (FVPT)	Ability to perform standardised tasks	148	102
	Near Visual Acuity			69,100,106,116,124,154
	The Pepper Visual Skills for Reading Test (VSRT)	Reading speed and accuracy	136	126
	Reading Accuracy			110
	Reading Comprehension			32,61
	Reading Speed			32,61,110
Activities of Daily Living / Functional Measures	Activity Card Sort (ACS)	Assesses participation levels in everyday activities		60 109
	The Daily Living Questionnaire (DLQ)	Assesses ability and confidence in everyday activities of increasing complexity	116	116
	Dependence level in ADL questionnaire	Assesses dependence level in ADL	132	48
	Effectiveness of Los Vision Rehabilitation Training (ELVERT)	Assesses Vision Related activities related to mobility, daily living skills, personal skills.		26
	Functional Assessment Questionnaire (FAQ)	Assesses activity level of people with visual impairments	3	102
	Functional Assessment of Self-Reliance on Tasks; Clinician Rated scale (FAST-CR) and patient Self-Report scale (FAST-SR)	To assess ability to perform ADL and IADL	95	110
	Functional Vision Status Questionnaire (FVSQ)	To assess subjective impairment severity	74,78	75
	Independent Living Pre-Programme Assessment and Post-Programme assessment (ILPPA)	Assesses ability to perform ADL thought to be critical for independent living among blind individuals.	34,144	118,144
	Independent Living Assessment Inventory	Assesses capacity for and performance of independent living skills		55
	Manchester Low Vision Questionnaire (MLVQ)	Task analysis and patterns of LVA use	63	70,115,122 ,124
	Melbourne Low Vision ADL Index (MLVAI)	Assesses ADL performance	65	65
	Older Americans Resources and Services (OARS) Multidimensional Functional Status Questionnaire	Assesses disability in ADL (not vision specific)	1	15,72,75
	Patient-Based Assessment of Difficulty in Mobility	To measure perceived visual ability for independent mobility	146,147	87
	Perceived security in performing ADL	Assesses perceived security/insecurity in performing ADL	40	41,49
	Reading Behaviour Inventory (RBI)	To assess difficulty reading items read on a daily/weekly basis, and frequency of reading, satisfaction with reading etc.	61	61

	Veterans' Affairs Low Vision Visual Function Questionnaire (VA LV VFQ-48)	Assesses functional ability of patients with visual impairment	141,142	137,138,143
	Visual Function Questionnaire (VF-14)	Assesses performance of vision-related activities	133	129
Vision-Related Quality of Life	The Impact of Vision Impairment (IVI) profile	Assesses functional, social and psychological factors	64,158	26,91
	13-item QOL measure	Assesses QOL factors which are adversely affected by loss of sight and directly addressed by non-vocational personal adjustment programmes	51	51
	Low Vision Quality-of-life Questionnaire (LVQOL)	Assesses functional, social and psychological aspects of quality-of-life in persons with low vision	160	43,149,160
	Measure of Functional and Psychosocial Outcomes of Blind Rehabilitation	Assesses QOL, as measured by functional capacity, feelings of self-worth and self-confidence	51	51,89
	NEI-VFQ (National Eye Institute Visual Function Questionnaire) 51 item	Assesses the effect of visual disability on health-related quality-of-life (including functional, social, psychological and physical elements)	97	129
	NEI-VFQ (National Eye Institute Visual Function Questionnaire 25 item (+appendix questions)	Assesses the effect of visual disability on health-related quality-of-life (including functional, social, psychological and physical elements) – shorter than 51 item version	98	88,89,92,126,137,140
	Vision Quality-of-life Core Measure (VCM1)	Assesses vision-related quality-of-life (psychological and social aspects)	59	43,70,115,122,149
Psychological statuss	Adaptation to Age-Related Visual Loss (AVL) scale	Assesses psychological adjustment to vision loss	74	26,60,73,109
	Centre for Epidemiological Studies Depression Scale (CES-D)	Measures self-reported symptoms associated with depression experienced in the past week in the general population	112	52,72,75,87,143
	Coopersmith self-esteem inventory	Assesses self-esteem	11,31	88
	Macular Degeneration Self-Efficacy Questionnaire (AMD-SEQ)	Assesses self-efficacy in AMD	24	60,109
	Elderly Care Research Center (ECRC) Coping Scale	Assesses types of coping strategies in older people	81	15
	Generalised Self-Efficacy Scale (GSES)	Assesses participants' strength of belief in ability to manage a wide range of everyday problems and difficulties	2,128	60
	Geriatric Depression Scale (GDS)	Distinguishes between normal, mildly and severely depressed elderly adults.	162	60,109,116
	Minnesota Multiphasic Personality Inventory (MMPI)	Assesses mental health in adults	117	5
	Zung self-rating depression scale	Quantifies the depressed status of a patient	7,163	5
Health Related Quality of	Euroqol thermometer	Assesses perceived general health related QOL	53	43
	Medical outcomes Short Form SF-36	Health-related QOL measure (multipurpose short form health survey)	157	48,60,109,115,122,129
	Medical outcomes Short	Assesses health-related QOL measure	156	87,88,91

	Form SF-12	(multipurpose short form health survey)		
	NEI-VFQ health status survey	To determine non-ophthalmic co-morbidities (addendum to NEI-VFQ vision related QOL tool)	[97]	[129]
	12-item QOL instrument	Assesses QOL by addressing vision attributable limitations important to ADL	[56]	[151]
	Single item QOL measure	Single item grading overall quality-of-life in the past 6 months		[89]
	WHO QOL instrument			[26]

Table 1. *The outcome measures employed by studies included in this review.*

Study/Study Design/Number of Participants	Intervention	Key Results (Cohen's d effect sizes where available, otherwise general outcomes)
Aki and Atasavun, 2007 [1] Before and after study; Follow-up 3 months; N=220	Training group: attended physiotherapy department. Control group: parents trained for one session in physio department, then conducted programme at home	Scores on five subtests were significantly higher in training group. No significant difference between groups on remaining three sub-tests.
Bernbaum et al., 1988 [5] Before and after study; Follow-up at end of rehabilitation programme; N=29	Intensive multidisciplinary programme for VI patients with diabetes: 12 weeks duration.	Effect sizes: Zung: stable group: 1.33, transitional group: 3.2; Rosenberg: stable group: 2.67, transitional group: 3.0; Diabetes self-reliance: stable group: 3.56, transitional group: 4.67
Boerner et al., 2006 NB/ same study as Horowitz 2005 [15,75] Before and after study; Follow-up at 24 months; N=155	3 interventions may have been accessed: 1) seeing a vision specialist; 2) receiving counselling; 3) receiving rehabilitation/ orientation and mobilty training	Effect sizes: 'Instrumental' coping: -0.65; No change in other coping strategies
Corn et al., 2002 [32] Before and after study**;** Follow up at least 4 months post-rehabilitation; N=185	LVAs prescribed to 70% of children	Effect sizes: 1.29 silent reading speed; 0.14 oral reading speed
Court et al., 2011 [33] Controlled before and after study; Follow-up at 3 months; N=488	Community-based low vision service (CLVS) including assessment, advice, provision of LVAs, referral to other services, follow-up. Hospital-based low vision service (HLVS) similar to above, but offering greater range of LVAs, greater experience of practitioner, availability of ophthalmologist for referrals, but no protocol for reassessment.	Significant reduction in visual disability of 0.46 logits and 0.57 logits in HLVS and CLVS respectively. No significant difference between groups in change in visual disability between groups.
Crossland et al., 2007 [36] Before and after study; Follow-up at 3 months; N=15	Optometrist led low-vision service including refraction, prescription of LVAs, advice on methods of enhancing vision e,g, lighting, facilitation of access to other services and referrals if required.	Patient satisfaction was assessed in a qualitative way by analysing results of semi-structured interview.
Dahlin Ivanoff et al., 2002 NB/ same study as Eklund 2004 and 2008 but different follow-up period [41,48,49] Randomised controlled trial; Follow-up 4 months; N=253; N=187 at 4 month follow up.	Health education programme: groups of 4-6 persons; 8 weeks; 2 hours per week; problem-solving model for carrying out ADLs. Individual intervention programme: standard intervention at low vision clinic; typically 1 to 2 x 1 hours at the clinic followed up by telephone contact.	The individual intervention gp showed systematic changes towards lower or unchanged perceived security in 23/28 ADLs. The health promotion/education group showed improvement in 22/28 ADLs. The mean change in RP (relative position of the group, where 1 = maximum improvement i.e. all individuals change from minimum score to maximum score, and -1 = maximum reduction) was -0.005 in the individual intervention group and 0.22 in the health education programme.
de Boer et al., 2006 [43] Controlled before and after; Follow-up 12 months; N=215 at follow-up.	Optometric low vision service or multidisciplinary rehabilitation centre, allocated by location. Optometric: LVAs with advice and instructions. Multidisciplinary: LVAs with advice and instructions, training in ADLs, counselling, advice on adaptation of home environment. Both services: follow up appointments as required.	Effect sizes: VCM1: 0.132, LVQOL: -0.17 (deterioration)
Dodds et al., 1993 [45] Before and after study; Follow-up within a few days of leaving centre; N=100	Inpatient low vision rehabilitation centre; 10 weeks social and vocational rehabilitation.	The following parameters were significantly improved post rehabilitation: Anxiety, self-esteem, acceptance, self-efficacy, hopelessness/depresssion. Actual data for each subscale only shown graphically in

		paper.
Eklund et al., 2004 NB/ same study as Dahlin Ivanoff 2002 and Eklund 2008, but different follow-up/outcomes [41,48,49] Randomised controlled trial; Follow up 28 months; N=131 at follow-up.	As in Dahlin Ivanoff et al., 2002	Analysis as in [41]. Mean RP score for the individual intervention at 28 months = -0.13, and for the health education group 0.22. The health education group showed statistically significant changes towards an improved level of security (RP) in 20 activities. The individual intervention group showed statistically significant changes towards a lower level of security in 12 activities.
Eklund et al. 2005 NB/ same study as Dahlin Ivanoff 2002 and Eklund 2004; 2008, but different follow-up/outcomes [41,48-50] Cost effectiveness analysis alongside randomised controlled trial; follow-up 28 months; N=131 at follow-up.	As in Dahlin Ivanoff et al., 2002	Average total costs for each service: SEK 28,004 [£2688] and SEK 36,341 [£3488] for the health education and 'usual care' services respectively. Average total cost per improved case was SEK 62,010 [£5,955] for the health education service compared with SEK 358,216 [£34,399] for 'usual care'.
Eklund et al., 2008 NB/ same as Eklund 2004 but different outcomes [48,49] Randomised controlled trial; Follow up 28 months; N=131 at follow-up.	As in Dahlin Ivanoff et al., 2002	Dependence in ADL: 39% of participants in health education programme and 22% of individual programme participants were independent at 28 months (i.e. were categorised as independent on all 9 activities). 32% of participants in the health education programme and 53% of individual intervention participants had moved at least one step towards more dependence.
Elliott and Kuyk, 1994 [51] Before and after study; Follow-up 4 months; N=40	Veteran's Affairs Inpatients Blind Rehabilitation Centre. Average 55 days intervention.	Significant improvement in all 13 QoL items.
Engel et al., 2000 [52] Before and after study; Follow-up up to 10 months (2 month intervals); N=80, N=70 completed follow-up.	Three agencies providing O&M training. Average 5 home visits by rehabilitation teachers (range 1-14). Average number of hours nearly 7 (range 1-21).	General Health: Significant reduction in number of times talked to doctor per 2 month period; ADLs: Significant improvement in difficulty using public transport in confidence using public transport; Social activities: Significant reduction in frequency per 2 months of seeing relatives, engaging in hobbies and in moderation of physical activity, significant increase in frequency of seeing friends and club related activities. Morale: significant improvement in sense of control.
Farish and Wen, 1994 [55] Before and after study; Follow-up at end of rehabilitation programme; N=57.	Independent living services programme. Training provided in O&M, communication and ADLs; low vision services and aids; family and peer counselling services. Facilitation of access to other instructors, counsellors and personnel of vision rehabilitation centres.	Effect sizes for capacity and performance, respectively: Travel and movement: 0.51, 0.18; Daily living skills (DLS) I: 1.08, 0.75; Visual functioning near tasks: 1.58, 1.03; Visual functioning distance tasks: 0.85, 0.47; Communication skills: 0.97, 0.30; DLS II: 1.15, 0.83
Girdler et al. 2010 [60] Randomised controlled trial; Follow-up 12 weeks; N=77.	Usual care (UC): one to one case management model, including home visit, visual assessment, LVA provision and referral to other services. Vision self-management (VCM): group (6-10 patients) model of service delivery; 8 week (24 hr) structured programme. Led by occupational therapist and social worker.	Over study, UC+VSM group showed increase then maintenance of participation (5% increase post test, maintained at follow up), UC participants showed gradual decline (5% decrease post test, maintained at follow up). On depression, health-related QoL and generalised self-efficacy, the UC+VSM group demonstrated significantly better outcomes than the UC group, with differences maintained at follow up. Adaptation to visual loss, and vision-specific self-efficacy

		measures showed significantly better outcomes for UC+VSM than the UC group, but difference lost at follow up.
Goodrich et al., 2006 [61] Before and after study; Follow-up 2 months; N=64	Inpatient Veteran's Affairs Reading Rehabilitation Programme. Prescription of best optical reading device, training in use of device, training in use of CCTV. 10 40-minute sessions held on successive days.	Change in reading speed pre- to post- test effect size: 1.01
Haymes et al., 2001 [66] Before and after study; Follow-up 1 week; N=22 at follow-up.	Multidisciplinary low vision service including a coordinator, ophthalmologist, optometrist, orthoptist, occupational therapist, orientiation and mobility instructor, welfare officer, vision impaired peer workers.	Effect size: 0.78
Head et al., 2000 [68] Before and after study; Follow-up at end of rehabilitation; N=230.	Veteran's Affairs inpatient transdisciplinary inpatient service. Goal-based training programme lasted from 10-117 days (mean length 42 days).	Effect sizes: IADL: 2.38; Health: 0.81 Mobility: 1.96
Hiatt et al., 1963 [69] Before and after study; Follow-up up to 5 years; N=276 questionnaires sent, N=130 replies received.	Low vision examination by an optical aids counsellor i.e. VA testing, magnification needs assessed by clinician and low vision aids prescribed where appropriate. Referral to other agencies if required.	Before the provision of LVAs 6.6% could read N8 or better, after provision of LVAs this rose to 76.7%. 86% of those who returned a questionnaire still had their spectacles or LVAs and 73% "felt general satisfaction". 65% state that they "read more than they did before getting the optical aid"
Hinds et al., 2003 [70] Before and after study; Follow up at 6 months (after initial appointment); N=80, N=71 at follow-up.	Interdisciplinary Low Vision Service based at 2 hospital low vision clinics. Tailored service included initial clinical assessment, provision of LVAs, diagnosis, referral for treatment, registration, information, counselling and support. Domiciliary follow-ups.	ADLs: Statistically significant increase in no. patients who had read/tried to read ordinary print. Significant decrease in no. patients who had read or tried to read large print and shop/prices/labels/tickets. Vision Related QoL: Statistically significant improvement in 3 areas at follow-up: fear of deterioration of vision, safety at home, coping with everyday life. Significant reduction in the average index score at time 2, indicating less overall worry.
Horowitz et al., 2000 [73] Before and after study; Follow-up immediately after service provision; N=432, N=395 completed study.	Adaptive Skills Training Program (AST). Taught ADLs, O & M; communication skills, use of adaptive equipment. Also counselling-facilitated discussion. 12-sessions (each 3-4 hours).	Effect sizes: AVL mean score: 0.42; Life satisfaction: 0.26; feelings of sadness or depression: -0.2; Managing daily household tasks: -0.12; getting to places outside the home: -0.64; caring for personal needs: -0.17. All of these indicate positive effect of rehabilitation.
Horowitz et al., 2005 (and Horowitz 2003 methods) [75,76] Before and after study; Follow-up 20-27 months after baseline; N=155, N=95 at follow-up.	Vision rehabilitation services could include: low vision clinical services, skills training, counselling, use of optical and adaptive devices. Types of services received determined on individual basis.	Effect size: CES-D: -0.045 (indicates improvement). 33.7% met criteria for significant depressive symptoms at baseline. 25.3% significantly depressed at follow-up
Horowitz et al., 2006 [72] Before and after study; Follow-up 6 months; N=584, N=438 at follow-up.	Community based vision rehabilitation services, mean number of 'service hours' = 5.8 (SD 7.9).	Effect sizes: Disability 0.05; Depression -0.11 (indicates improvement)
Kim et al., 2003 [85] Controlled before and after study; Follow-up at end of intervention; N=13 training, N=13 controls.	Assertiveness training in school setting – 12 lessons.	No significant improvement in any outcome measure
Kuyk et al., 2008 [88] Before and after study; Follow-up 2 and 6 months;	Department of Veteran's Affairs inpatient blind rehabilitation programme. Average length of stay = 6-7 weeks. Each training day	Effect sizes refer to those observed at 2 and 6 month respectively for the significant NEI VFQ subscales: General health:-0.22, -0.27;

N=206, N=197 completed all interviews.	includes 7, 45 minute instruction periods.	General Vision: 0.28, 0.24; Near Vision:1.49, 1.44; Distance Vision: 0.68, 0.56; Colour Vision: 0.27, 0.25; Role Difficulties: 0.44, 0.35; Dependency: 0.41, 0.43; Social Function: 0.33, 0.33; Mental Health: 0.38,0.43; Composite Score: 0.59, 0.55
Kuyk et al., 2004 [87] Before and after study; Follow-up 2 months; N=128 completed rehabilitation programme.	Department of Veteran's Affairs inpatient blind rehabilitation programme. O&M training according to individual needs. ~35-40 hours spent in training by most patients over average 6 week program.	Mobility questionnaire: Part 1: All but 1/34 mobility ratings moved in the direction of less difficulty at follow-up. Significant difference found for 26 of 34 (76% of items). Part 2: Significant increase in confidence in travel in unfamiliar places, in stores and outdoors. No significant difference in confidence in travel in familiar places.
La Grow, 2004 [89] Controlled before and after study; Follow-up 6 months and 1 year; N=93 (test group and contrast group), N=70 (test group) N=67 (contrast group) at 1 year.	Integrated services at low vision clinics at 4 population centres. Experimental group: Assessment of ocular health and function, provision of LVAs, with training, follow-up visit in homes, with repeated instruction visits if required. Contrast group received services normally available to them.	The follow effect sizes refer to those observed at 2 and 6 month respectively: NEI VFQ-25: experimental group: 0.06, -0.18; contrast group 0.10, 0.11. IADL: experimental group: 0.18, -0.03; contrast group -0.07, -0.04. QOL: experimental group at 6 0.07, -0.12; contrast group 0.01, 0.14.
Lamoureux et al., 2007 [91] Before and after study; Follow-up 3-6 months; N=254 baseline; N=192 follow-up.	Multidisciplinary low vision service. Intervention lasted up to 6 months (sometimes just one visit). On average clients made 4 visits to the multidisciplinary team.	Effect sizes: Mobility and independence: 0.17; Reading and accessing information: 0.20; emotional well-being: 0.30; overall score: 0.25
Langelaan et al., 2009 [92] Before and after study; Follow-up 3 and 12 months post-rehabilitation; N=129.	Multidisciplinary low vision service including optometry, occupational therapy, mobility training, psychological (group) sessions, social work. Mean duration 18 weeks.	Significant improvement in Distance Activities and Mobility and Mental Health and Dependency subscales at 3 months compared to baseline. Mental health and dependency scale showed significant improvement at 1 year compared to baseline, all other factors were not significant.
Margrain, 2000 [100] Before and after study (retrospective); Follow-up immediately post-intervention; N=168.	Low vision assessment at university low vision clinic, including: history and symptoms, assessment of patient requirements and visual performance, refraction, and provision of appropriate LVA.	LVAs significantly improved ability to read newsprint i.e. N8 text (23% without LVA, 88% with LVA).
McCabe et al., 2000 [102] Randomised controlled trial; Follow-up at end of rehabilitation; N=48 individual intervention, N=49 family intervention.	All participants attended integrated, hospital based vision rehabilitation service. Individual protocol: all family members were excluded from all sessions. Family protocol: family members (or friend/carer/neighbour) included in all stages of rehabilitation.	Across both groups: Statistically significant gain in visual capacity, and decrease in dependency, and in self-reported difficulty performing tasks. No significant difference between family and individual intervention groups at end of treatment
McKnight and Babcock-Parziale, 2007 [104] Before and after study; Follow-up at end of rehabilitation; N=81 provided complete data.	Multidisciplinary inpatient rehabilitation scheme for 'blind' veterans.	Systematic shift in response ratings (towards more functional ability) between pre- and post- intervention.
Needham et al., 1992 [105] Controlled before and after study; Follow-up at end of rehabilitation; N=112 blind veterans, N=67 controls.	3 month adjustment to blindness programme. Included training in mobility, communication, braille, manual skills, adjustment to daily living. Also nurse, social worker and psychologist gave detailed evaluations and testing. Intensive psychological treatment available to patients during stay.	Effect sizes: Ability: psychiatric disorder: 0.59, no disorder: 0.51; Attitude: disorder: 0.65, no disorder: 0.55; overall adjustment: disorder: 0.62, no disorder: 0.50
Nilsson, 1986a [108] Before and after study; Mean follow-up 3.6 years; N=115,	Hospital low vision clinic. Ophthalmic optician and low vision teacher prescribed advanced optical aids and gave training in	Effect sizes: Dist VA: Baseline to after 1st visits: 2.95; baseline to after final visits: 1.81. Near VA: Baseline to after 1st visits: 2.41;

N=79 attended for follow-up.	use of aids and residual vision. Less than 2 hours training per year on average.	baseline to after 2nd visits: 1.02
Nilsson 1986b [107] Before and after study; Mean follow-up 5 years; N=120.	Low vision clinic, department of ophthalmology. Hospital low vision clinic. Ophthalmic optician and low vision teacher prescribed advanced optical aids and gave training in use of aids and residual vision. Less than 2 hours training per year on average.	Effects Sizes: Dist VA: Baseline to after 1st visits: 2.10; baseline to after 2nd set of visits: 1.48. Near VA: Baseline to after 1st visits: 2.10; baseline to after 2nd visits: 1.52
Packer et al., 2009 [109] Before and after study; Follow-up post-rehabilitation and at 12 weeks; N=13.	8 week vision self-management programme. 6-8 patients per group. 2 trained health professionals (occupational therapist and social worker) delivered the programme using detailed protocol. Participants received VSM in addition to usual care.	Effect size (calculated from values given rather than using effect sizes in paper, as not clear whether Cohen's d techniques used): ACS: pre-post: 0.60; pre-follow up: not significant; GDS: pre-post: 0.60; pre-follow-up: 0.79; SF-36 MCS: pre-post: 0.65; pre-follow-up: 0.96; SF-36 PCS - not significant; AVLS: pre-post: 0.73; pre-follow-up: 0.98; ARVL-SEQ: pre-post: 3.16; pre-follow-up: 3.44.
Pankow et al., 2004 [110] Randomised controlled trial; Follow-up 1-1.5 months; N=15 (treatment group), N=15 (control group).	Treatment group: Home-based vision rehabilitation programme including low vision evaluations and optical aids, O&M, and/or blind rehabilitation teaching. Certified driver rehabilitation specialist and occupational therapist available. Control Group: education about diagnosis, demonstration of aids for functional enhancement, and telephone information of when rehabilitation would begin.	Significantly better score gains for the treatment than control group for FIMBA living skills and NAS2, but not for FIMBA orientation and mobility scores. Goal attainment was significantly better for the treatment group (29/30) than for the control group (1/30).
Rees et al., 2010 [114] Post-test study; Data collected post-rehabilitation only; N=15.	Self-management programme incorporating 8 weekly 3 hour facilitated group sessions. Includes guest presenters e.g. orthoptist to demonstrate LVAs, O&M instructor. Option to bring a friend/relative.	N=11 reported using additional optical and non optical aids as a result of the programme. All participants agreed that it was worth their time and effort, and would recommend to others.
Reeves et al., 2004 (results) and Russell et al., 2001 (methodology) [115,122] Randomised controlled trial; Follow-up 12 months; N=226, N=194 at follow-up.	Conventional low vision rehabilitation (CLVR): optometric low vision intervention, follow-up at 3 months with additional appointments (up to 12 months). No formal integration with other services. Enhanced low vision rehabilitation (ELVR): Optometric intervention plus three home visits within 6 months. Controlled for additional contact time in ELVR (CELVR): Optometric intervention, plus community care worker to provide general advice and support - visits at same intervals as home visits in ELVR.	During follow up, all visual functions deteriorated in all groups. Use of LVAs high throughout trial in all groups. Effect sizes only available for comparisons between groups: SF-36 physical component score: ELVR vs. CLVR effect size = -6.05 scale units (CLVR better); ELVR vs. CELVR effect size = -3.78 scale units (CELVR better); SF-36 mental component score: ELVR vs. CLVR effect size = -4.04 (CLVR better).
Robbins and McMurray, 1988 [116] Before and after study; Follow-up at end of rehabilitation process; N=57 with outcome data.	Multidisciplinary low vision clinic	Effect sizes: Depression: 0.39; Daily Living Skills: 0.32; Near VA: 0.75
Rogers et al., 2000 [118] Controlled before and after study (retrospective); Follow-up at end of rehabilitation; N=85 (consultant model), N=507 (rehabilitation model)	Consultant model: Consultants trained home care managers of Area Agencies on Aging to assess the need for rehabilitation services, and home care aides to provide services. Rehabilitation model: used rehabilitation teachers to assess service needs and carry out instruction.	Type of service only explained 2% of variance for mobility, and 4% for text access. Type of model did not affect outcomes in the domains of ADL, IADL and cooking.
Ruddock et al., 2004 [121]	Low vision assessment, LVAs where	Before service set-up, 25% of children had

Before and after study; Follow-up period not clear; N=32.	appropriate.	LVAs of whom 21% used regularly, After service set-up, 91% children seen by service had LVAs of whom 86% used them regularly.
Ryan et al., 2010 [124] Before and after study; Follow-up at 3 months; N=343	Hospital and optometric practices, and 1 university eye clinic in Wales. Service provided by optometrists, ophthalmic medical practitioners, and dispensing opticians with diploma in low vision. All trained and accredited.	Reduction in visual disability from baseline of 0.79 logits (P<0.001). Significant improvement in median near VA from N12 to N5 post-service. 92% of those prescribed magnifiers had used during past week, 98% of patients found service helpful.
Scanlan and Cuddeford, 2004 [126] Randomised controlled trial; Follow up at 5 and 12 weeks after admission into study; N=64 (N=32 per group).	Control: Education session 60 minutes. Review in 1 week. LVA provision. Reading exercises given. 6 month telephone call to determine effectiveness of devices. Experimental group: As control, but extended teaching programme (5x1 hour sessions over weeks 1-4, one-on-one with rehabilitation worker).	No significant differences over time on control group Pepper scores; experimental group showed significant improvement at time 2 on reading accuracy and reading rate, but no sig difference between time 2 and 3.
Scott et al., 1999 [129] Before and after study; Follow-up 3 months; N=156.	Low vision examination (60-90 mins) including goals, refraction, training in use of LVAs, eccentric viewing training and/or prism relocation (if required).	Effect sizes: No significant change in SF-36. VF-14: 0.42; NEI-VFQ general vision: 0.34; near activities: 0.59; distance activities: 0.21; peripheral vision: 0.33
Stelmack et al., 2002 [140] Comparison of 2 before and after studies; Follow-up at end of rehabilitation service; N=128.	Hines VA BRC: a comprehensive interdisciplinary inpatient rehabilitation programme. Average duration 42 days. VICTORS: less intensive interdisciplinary programme. 3-4 days inpatient or outpatient treatment.	For BRC patients, 7 NEI VFQ-25 items were easier to perform, in comparison with other items, after rehabilitation. In VICTORS 4 items were significantly less difficult after rehabilitation. Post rehabilitation visual ability was greater than pre-rehabilitation (BRC average increase of 0.51 logit; VICTORS 0.35 logit).
Stelmack et al., 2006a [137] Comparison of 2 before and after studies; Follow- up 3 months (and 36 months at one centre); N=282.	Interdisciplinary Veterans' Affairs inpatient rehabilitation programmes (Southweatern BRC and Hines BRC). Both centres use nurse practitioner, nursing, optometry, psychology, social work, and blind rehabilitation specialists. Offer courses in visual skills, living skills, orientation and mobility, manual skills, plus psychosocial interventions and recreational activities.	Southwestern BRC data: No significant change in scores at 3 months post rehabilitation. Hines BRC data: 7 NEI VFQ-25 items were sensitive to change after rehabilitation. Significant improvement in visual ability at 3 months (equivalent to 0.425 logMAR). At 3 year follow up, reduction in difficulty of 7 NEI VFQ items persisted. Small improvement in visual ability did not persist.
Stelmack et al., 2006b [141] Controlled before and after; Follow-up 3 months; N=285 (inpatient N = 139, outpatient N = 116, control N = 30).	Inpatient programme (Hines BRC): mean stay 40 days. The outpatient programme included low vision evaluation, prescription of LVAs, training in their use and involved 2-4 therapy sessions.	Effect sizes: Inpatient: 2.1; Outpatient: 0.26
Stelmack et al., 2007 [138] Before and after study; Follow up 3 and 6 months; N=178, N=95 provided data for both follow-up times.	Inpatient programme (Hines BRC): mean stay 40 days.	An effect size of 2.035 and 1.405 is reported at 3 and 12 months respectively (could not be calculated independently due to lack of data)
Stelmack et al. 2008 [139,143] Randomised controlled trial; Follow-up 4 months; N=64 treatment group, N=62 control group.	Interdisciplinary outpatient Veterans' Affairs low vision programmes at 2 facilities. 5 weekly sessions (approx 2 hours each); 1 home visit; 5 hours homework per week. Treatment and control group bi-monthly phone calls for 4 months. Waiting list control group.	Effect size (treatment vs. controls): Reading ability: 2.51; Mobility:1.14; Visual Information processing: 1.38 2.03; Visual motor skills: 1.82; Overall visual function: effect size 2.51
Stephens, 2001 [144] Before and after study; Follow-up at end of rehabilitation programme; N=1,194.	Low vision programmes representing 4 models of service provision for older blind people. Could include: independent living skills training, counselling, devices, communication aids; mobility training; interagency referral.	The following effect sizes describe performance and independence, respectively: Age 65-74: ADL: 0.43, 0.65; IADL: 0.54, 0.57. Age 65-84: ADL: 0.46, 0.60; IADL: 0.62, 0.51. Age 85+: 0.33, 0.53; IADL: 0.58, 0.54. Age all: ADL: 0.41, 0.59; IADL: 0.59,

		0.53
Stroupe et al. (2008) [145] Cost consequence analysis comparing treatment groups from 2 previous RCTs; Follow-up at 4 months (outpatients) and 3 months (inpatients); N=176.	Programme included teaching eccentric viewing skills, use of LVAs, prescription and issuance of devices delivered in either an inpatients or outpatients setting. Outpatients: Initial LV examination, 5 sessions of 1.5 to 2.5 hrs, 1 home visit and home study. Total 44.6 hours (SD = 12.1hrs). Inpatients: 42.0 days (SD 9.2 days).	The costs for the inpatient group were higher, per inpatient the cost was US$43,682 [£23,795] (SD US$8,854 [£4,823]) compared with the mean outpatient cost of US$5,054 [£2,753] (SD US$405 [£221]); difference US$38,627.3 [£21,040] (95%CI: US$17,414-US$273,482)
Van Nispen et al., 2007 [149] Before and after study; Follow-up 5 and 12 months; N=296, N=215 at 1 year.	As in de Boer et al., 2006 [43]	Optometric group: VCM1 significantly improved at 5 mths and 1 year. No change in the original LVQOL subscales at 5 months or 1 year. Multidisciplinary group: VCM1 significantly improved at 5 months and 1 year. Significant deterioration in the 'mobility' dimension of the LVQOL at 1 year but significant improvement in the 'adjustment' and 'reading and finework' dimensions at 5 months.
Vijaykumar et al., 2004 [151] Before and after study; Follow-up 6 months; N=159.	Community based rehabilitation programme in rural area of S India. Full eye exam at base hospital before referral to programme provided by community workers. Focused on providing skills to run a trade or pursue a profession.	Effect sizes (quoted in paper, not clear have calculated): Self care: 2.15, mobility: 2.38, social: 1.49, mental: 1.27, overall: 2.36
Virtanen and Laatikainen, 1991 [154] Before and after study; Follow-up at end of service provision; N=65.	Hospital low vision unit. Ocular exam, LVAs fitted by joint negotiation between ophthalmologist, optician, low vision teacher and patient.	13.8% were able to read newsprint with the correct reading correction, this improved to 91.4% with LVAs. N=26 achieved a near VA with magnifier of at least 0.5 (snellen decimal).
Walter et al., 2007 [155] Retrospective before and after study; Pre and post interviews together approximately 1 year after service provision; N=417, N=337 had low vision.	Multidisciplinary low vision clinic including low-vision optometrist, occupational therapist, social worker, orientation and mobility instructor, vision teacher.	Near Vision activities: 9/11 showed statistically significant improvement in rated difficulty. Distance-vision activities: all 3 items showed statistically significant improvement. Vision-related social activities: 2/7 showed statistically significant improvement.
Wolffsohn et al., 2000 [160] Before and after study; Follow-up 1 month; N=515 sent questionnaires, N=278 completed questionnaires.	Multidisciplinary low vision clinic. A 15 minute to 30 minute interview with a case manager. A 60 minute low vision assessment with an optometrist. Services from multidisciplinary team as appropriate.	Effect size: LVQOL: 0.28

Table 2. *Table studies included in this review, detailing study design, service details, and results.*

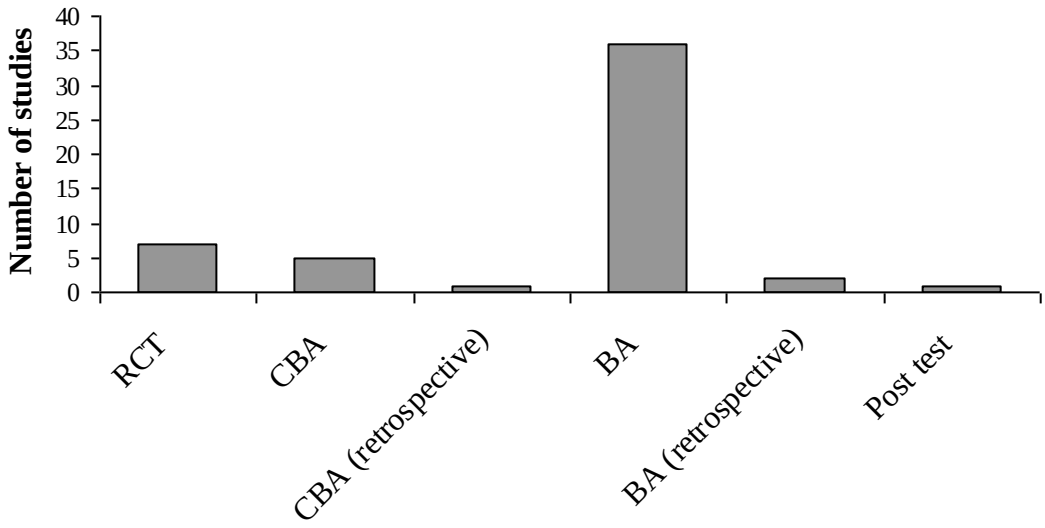

Figure 1. *Breakdown of included studies by study design. RCT = Randomised controlled trial, CBA = controlled before and after study, BA = before and after study*

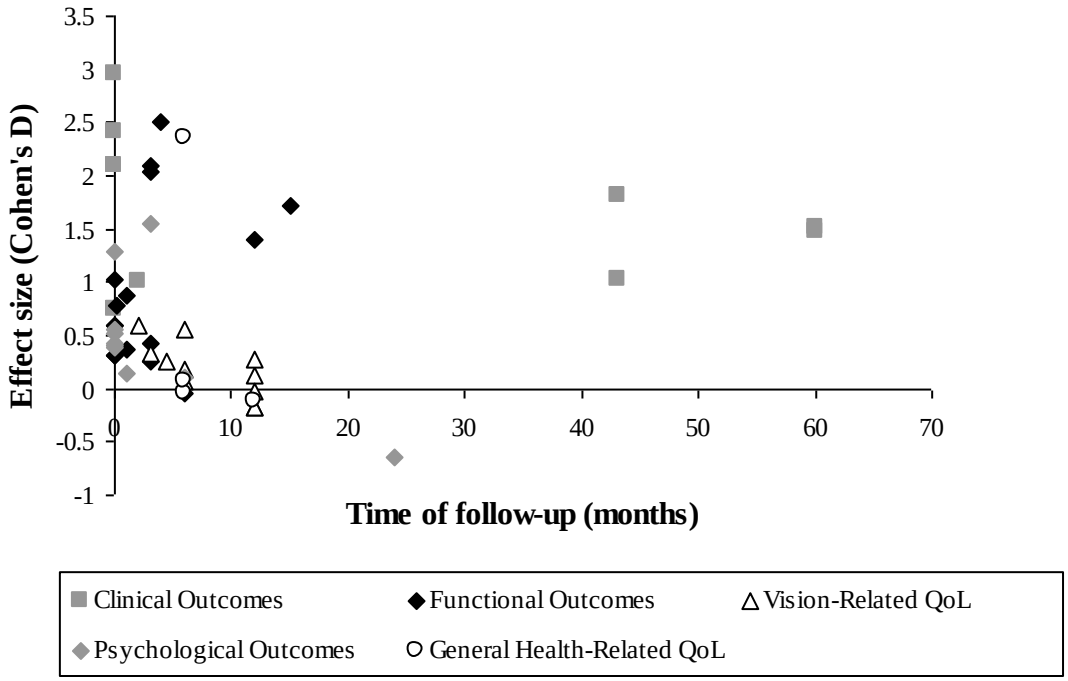

Figure 2. *Effect size plotted as a function of follow-up time (in months) for studies in which effect sizes could be calculated* [5,15,43,55,61,66,68,72,73,75,88,89,91,105,107-110,116,129,138,141,143,144,151,160]. *When multiple outcomes were assessed, more than 1 effect size is shown per study.*

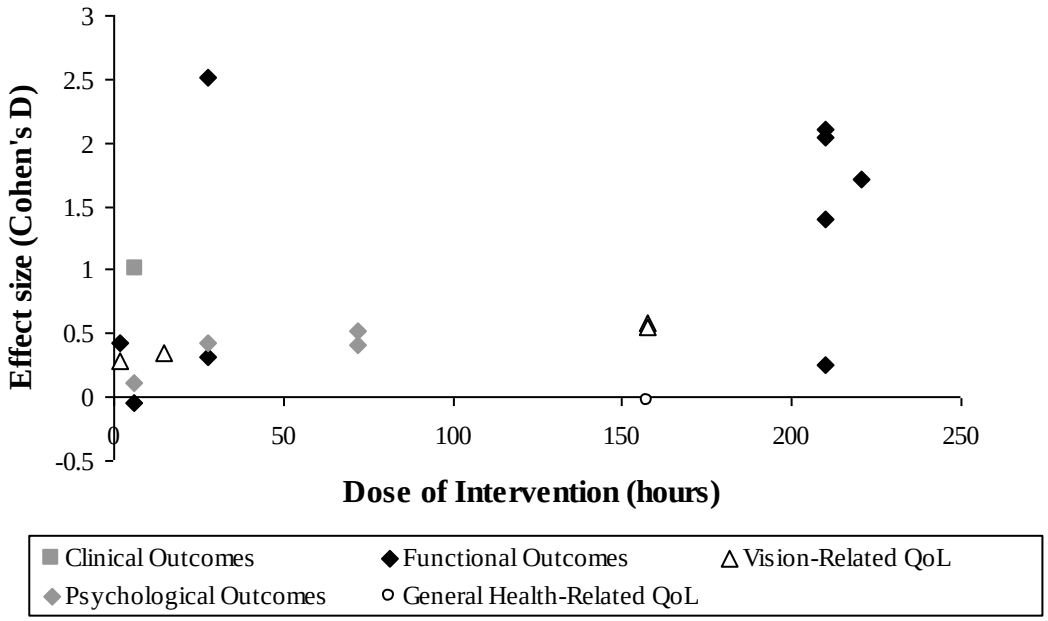

Figure 3. *Effect size plotted as a function of "dose" in hours for studies in which effect sizes could be calculated, and where sufficient information regarding the intensity of intervention was provided* [5,61,68,72,73,88,129,138,140,141,160]*. When multiple outcomes were assessed, more than 1 effect size is shown per study.*