Canadian research contributions to low vision rehabilitation: A quantitative systematic review

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The field of low vision rehabilitation developed out of the need for rehabilitation services for partially sighted individuals whose requirements differed from those who were blind.[1] Since its development was practice-driven, research in this area initially developed in a more responsive fashion, addressing questions that emerged from the clinic. Therefore, clinical practice had been leading the development of the field of low vision rehabilitation (LVR) and research followed. More recently, research concerning LVR has taken a more balanced position whereby both clinical practice and research findings inform and guide each other, advancing the field in the tradition of evidence-based practice.[2] This advancement includes professionals in ophthalmology, optometry, low vision therapy, psychology, nursing, orientation and mobility, and rehabilitation teaching, to name a few.

CONTRIBUTIONS DE LA RECHERCHE CANADIENNE À LA RÉADAPTATION DE LA BASSE VISION : UN EXAMEN SYSTÉMATIQUE QUANTITATIF

RÉSUMÉ

Objet : La recherche sur la réadaptation de la basse vision est un domaine à croissance rapide en partie à cause d'une demande accrue de services adaptés à des adultes vieillissants affectés d'une perte de vision associée à l'âge. Diverses professions collaborent à de tels services de réadaptation, cependant, on ne sait trop quelle profession prend les devants pour repousser les limites de la recherche sur la réadaptation de la basse vision. Un récent article de synthèse a indiqué que c'était les médecins qui jouaient ce rôle au Canada. La présente étude a été menée pour reproduire ces résultats dans le cadre d'un examen systématique.

Méthode : Une recherche dans sept banques de données et une recherche manuelle dans quatre journaux sur la réadaptation de la vision ont permis de retracer des articles sur la réadaptation de la basse vision dont le premier auteur était affilié à un établissement canadien. On a totalisé les données sur les titres professionnels, la provenance du financement et le contenu de l'étude.

Résultats : Des 1 870 références, on a extrait les données de 215 articles pertinents. Les quatre principaux titres des auteurs étaient : optométristes (avec ou sans doctorat; 56 communications – 26,0 %); chercheurs avec doctorat seulement (48 communications – 22,3 %); chercheurs avec maîtrise (43 communications – 20,0 %); et docteurs en médecine (avec ou sans doctorat; 39 communications – 18,1 %). Les journaux spécialisés en réadaptation de la vision ont publié 38 % de toutes les communications, suivis des journaux en ophtalmologie (27 %) et en optométrie (22 %). Les publications des 11 dernières années ont représenté plus de 50 % de toutes les communications produites dans ce domaine au Canada pendant les 64 années d'existence des publications, dont 70 % proviennent des universités.

Conclusion : Les résultats reflètent la mosaïque de la recherche sur la réadaptation de la basse vision au Canada et mettent en évidence la collaboration qui s'est installée entre les chercheurs, les cliniciens, les sources de financement et les organismes de réadaptation. Étant donné sa nature pluridisciplinaire, la recherche sur la réadaptation de la basse vision semble s'appuyer sur la collaboration entre les professions.

ABSTRACT

Purpose: Low vision rehabilitation research is a quickly growing area, due in part to the increase in the demand for services geared at older adults with age-related vision loss. Various professions collaborate to provide such rehabilitation services; however, it is currently unclear which profession takes the leading role in advancing the frontiers of low vision rehabilitation research. A recent review article proposed that in Canada, this role is held by physicians. The present study was conducted to replicate these findings under conditions of a systematic review.

Method: A search of seven databases and a hand-search of four vision rehabilitation journals identified articles on low vision rehabilitation whose first author had an affiliation at a Canadian institution. Data on professional credentials, funding source, and study content was tabulated.

Results: Of the 1,870 references, data from 215 eligible articles were extracted. The top four author credentials were optometrists (with or without PhD; 56 papers, 26.0%), followed by researchers with PhDs only (48 papers, 22.3%), researchers with master's degrees (43 papers, 20.0%), and medical doctors (with or without PhD; 39 papers, 18.1%). Vision rehabilitation journals published 38 per cent of all papers, followed by ophthalmology (27%) and optometry journals (22%). Publications in the past 11 years amounted to over 50 per cent of the output over the 64-year publication history in this field in Canada, 70 per cent of which were based in universities.

Conclusion: The results reflect the mosaic structure of low vision rehabilitation research in Canada, highlighting collaborations among researchers, clinicians, funding sources and rehabilitation agencies. Given its multidisciplinary nature, low vision rehabilitation research seems to be driven by collaboration among the professions.

Key words: *review, systematic, vision, low vision rehabilitation, activity, research, Canada, ophthalmology, optometry*

A publication by Teichman and Markowitz[3] recently suggested that, with research conducted in Canada, most resulting publications in LVR had first or corresponding authors with a medical degree (MD) (48.1%) who published in ophthalmology journals (44.3%). Based on their review of the literature, the authors proposed that even though optometrists have a more longstanding history in providing LVR services, the medical profession seems to play a leading role when it comes to research publication in LVR. These findings were called into question by optometrists due to some methodological and categorization issues[4] and sparked continued discussion.[5] Since such a leadership role would be of great importance for questions of research funding and policy development, the question of LVR research in Canada should be revisited. We decided, however, that it might be easier to address this topic if the investigators involved are neither working in, nor affiliated with, optometry or ophthalmology, but work within a rehabilitation research setting itself. In collaboration with a professional librarian, we decided to replicate the study by Teichman and Markowitz[3] and address the previously raised concerns[4] as well as applying methodological standards for systematic reviews[6], thereby following the encouragement of Markowitz[5] himself to replicate his findings.

Method

The following databases were accessed during the electronic component of the systematic review: Cochrane, Medline via OVID, Medline via OVID in Process, Embase, AMED, Web of Science, and CINAHL. The search included articles published on or before December 14, 2010. There were no language exclusion criteria and all studies were either in English or French. The search terms were based on the search initially used by Teichman and Markowitz[3], with minor additions but no deletions. For those databases where the author country was 'coded', a filter was utilized to reduce the number of results accordingly. In addition, we searched three low vision-specific journals electronically, that are not entirely coded within these databases (Visual Impairment Research, Journal of Visual Impairment and Blindness/JVIB 2000-2010, AER Journal). Furthermore, we hand-searched four peer-reviewed journals that are not completely available electronically (Canadian Journal of Optometry (CJOpto), Canadian Journal of Ophthalmology (CJOpth), New Outlook for the Blind, Re:View). Finally, we contacted Teichman and Markowitz for a list of their included studies. Based on their

most frequently listed authors, we contacted the six most-cited researchers in Canada in order to obtain a copy of their CVs. Any additional references were then added to the total list and entered into an EndNote file for processing (n = 1870).

The initial elimination process consisted of a scan by one reviewer (Walter Wittich) of titles and abstracts alone in order to eliminate all references that were obviously not related to low vision or rehabilitation. This reduced the EndNote file to 434 references. The second review of titles, abstracts and texts (if necessary) was conducted by two reviewers (Donald H. Watanabe and Walter Wittich). The inclusion criteria reported by Teichman and Markowitz[3] were generally adopted for the present review, however, a more detailed definition of the exclusion criteria was required because it was decided that these parameters could be improved. Research articles that focused on functional vision and visual function deficits and their measurement in general (not in the context of low vision) were excluded from the review (i.e. papers on visual perimetry, colour vision or acuity measurement). In addition, topics such as aging, blind sight, amblyopia, cataract, and cortical reorganization in the blind were also excluded, since they do not directly relate to the rehabilitation process. It was decided that the first author must have an affiliation at a Canadian institution or organization at the time of publication (this differs slightly from Teichman and Markowitz who state that the work also had to be conducted at a Canadian institution). When applying these standards to the publication list provided by Teichman and Markowitz, 73 papers from their review were excluded.

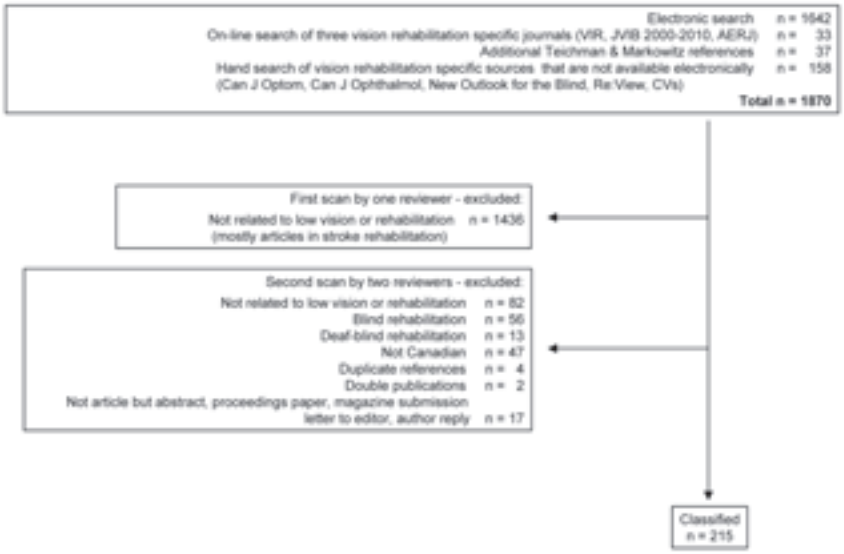

Figure 1 – *Systematic literature review process and classification results.*

In order to further facilitate the evaluation, additional limits and clarifications were established, which regulated the exclusion of studies focused on blind rehabilitation, braille in the context of blind rehabilitation, cane travel, and orientation and mobility skills of blind individuals, dual sensory impairment, and basic science that had indirect relevance to low vision rehabilitation. The driving question behind the development of these criteria was whether each examined paper intended to improve or inform any aspect of low vision rehabilitation in the applied context. Finally, the publication by Teichman and Markowitz itself was excluded.

Results

Figure 1 demonstrates how the 1,870 references were classified and by which criteria they were excluded. The 215 articles that were included in the final classification were obtained through the library resources of McGill University, the Université de Montréal or through interlibrary loan. The majority of the first authors who published low vision rehabilitation research articles included optometrists (with or without PhDs) who wrote 56 of the 215 papers (26.0%), followed by researchers with PhDs only (48 papers, 22.3%), medical doctors (with or without PhDs; 39 papers, 18.1%), researchers with master's degrees (43 papers, 20.0%), bachelor's degrees (19 papers, 8.8%) and those of unknown background (10 papers, 4.0%; see *Figure 2*). Most of the research was conducted at

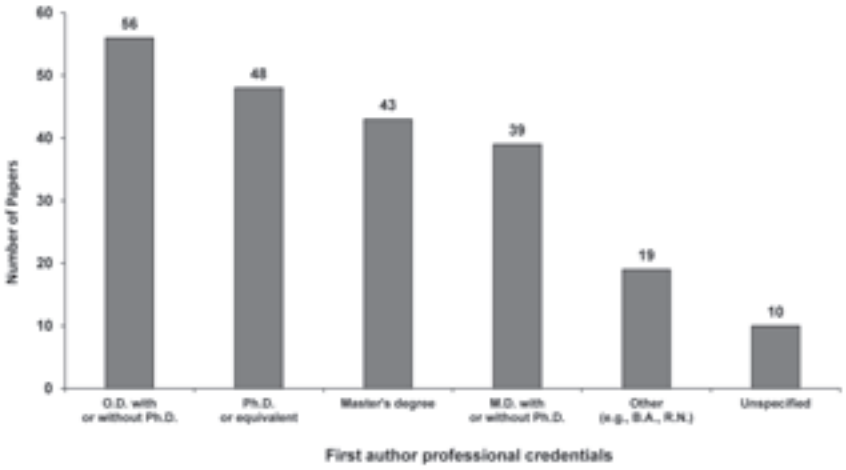

Figure 2 – *Frequency of publications as a function of the professional credentials of the first author. OD = Doctor of Optometry, PhD = Doctor of Philosophy, MD = Doctor of Medicine, BA = Bachelor of Arts, RN = Registered Nurse*

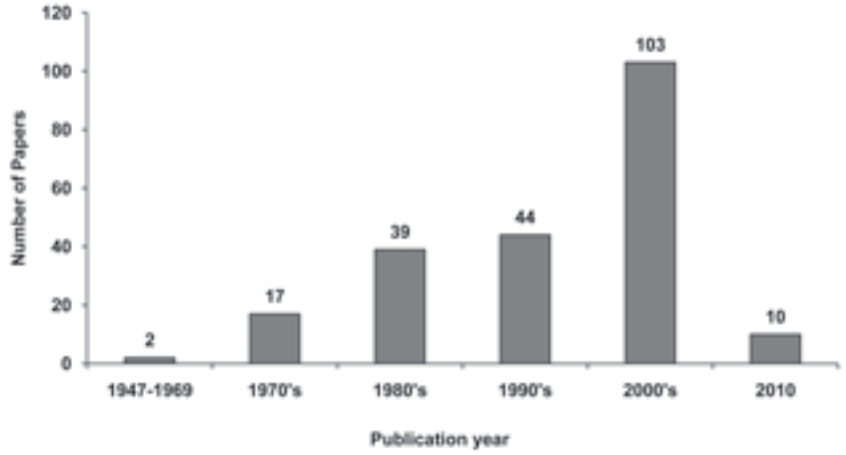

Figure 3 – *Number of publications by Canadian first authors in low vision rehabilitation as a function of publication year.*

the University of Waterloo (39 papers, 18.1%), University of Toronto (20 papers, 9.3%), Université de Montréal (15 papers, 6.9%), and the University of British Columbia (14 papers, 6.5%). Other Canadian universities (63 papers, 29.3%), low vision rehabilitation centres (26 papers, 12.1%), and hospital-based research units (15 papers, 7.0%) comprised the remainder of the institutions. Given the institutional distribution, it was not surprising that researchers in the Province of Ontario generated the majority of papers (118 papers, 54.9%), followed by Quebec (55 papers, 25.6%), British Columbia (22 papers, 10.2%), the atlantic provinces (10 papers, 4.7%), and the Prairies (9 papers, 4.2%). Of the 155 papers (72.1%) that originated from departments within universities, those from optometry (50 papers, 32.3%), ophthalmology (35 papers, 22.6%), psychology (22 papers, 14.2%), and other departments such as engineering (19 papers, 12.3%), and rehabilitation (11 papers, 7.1%) were the most represented.

The articles were published in vision rehabilitation journals (82 papers, 38.0%), ophthalmology journals (58 papers, 26.9%), optometry journals (47 papers, 21.8%), and other publications (29 papers, 13.4%). The journal with the most publications was JVIB (50), followed by CJOph (45), CJOpto (20) and OVS (10). English was the most common language of publication (208 articles), followed by French (7). Publication dates ranged from 1947 to 2010. The exponential-like growth of research in low vision rehabilitation is shown in *Figure 3* where the number of research articles published in the past 11 years (2000 through 2010) is over 50 per cent of the output over the 64-year publication history in this field in Canada. Among the 83 articles (38.6%) that stated their funding source(s), the majority of the research was funded by research consortiums and collaborations among hospitals, universities and private sources (31.1%). The remaining sources included Canadian federal and provincial

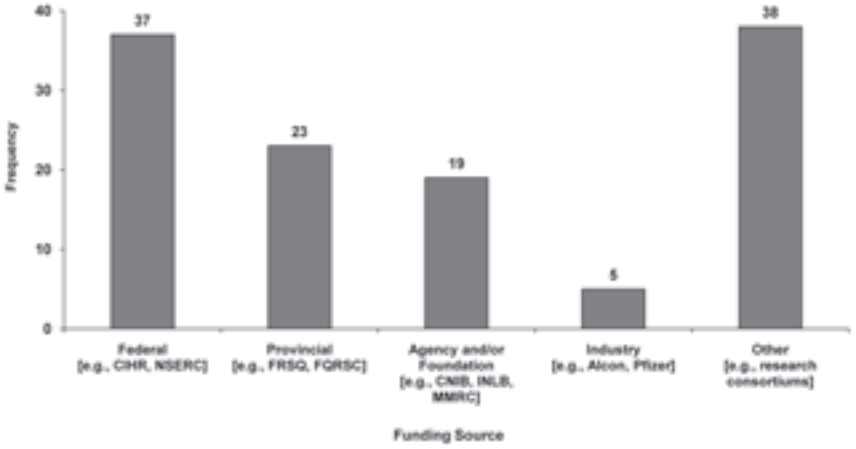

Figure 4 – *Number of publications as a function of their funding source. CIHR = Canadian Institutes of Health Research, NSERC = Natural Sciences and Engineering Research Council of Canada, FRSQ = Fonds de recherche en santé du Quebec, FQRSC = Fonds de recherche sur la société et la culture, CNIB = Canadian National Institute for the Blind, MMRC = MAB-Mackay Rehabilitation Centre, INLB = Institut Nazareth et Louis-Braille*

granting agencies, rehabilitation agencies as well as industry (*Figure 4*). Given that many projects had more than one funding source supporting their research efforts, the number of sources exceeds the number of articles aforementioned. Further, the majority (132 articles, 61.4%) did not specify their funding source(s).

The 215 articles that were included in the final classification were categorized into 12 different fields of research interest, with many of the papers addressing more than one topic area (see *Table 1*). Research concerning service delivery, psychosocial effects of visual impairment, applied optics/assistive technology and review articles accounted for 50.6 per cent of all papers. For those

Table 1: Topic area categories

MANUSCRIPT TOPIC AREA	Number	%
Service delivery – Models, program evaluation, information access, awareness	56	18.6
Review – LV-related diseases, treatment effectiveness, topic summaries (e.g., binocular vision)	44	14.6
Psychosocial – Coping, self-concept, social participation, treatment satisfaction	35	11.6
Applied optics and psychophysics, assistive technology/low vision aids	34	11.3
Assessment – Development/validation of questionnaires, clinical and functional tests	30	10.0
Visual function and functional vision – Acuity, useful field of vision, activities of daily living (e.g., reading labels)	23	7.7
Policy – Advocacy, recommendations to meet projected service demands	17	5.7
Epidemiology – Demographics, prevalence and etiology, risk factors	16	5.3
Other – Comorbid impairments, driving, employment, utility	16	5.3
Public health – Patterns of referral and compliance, disparities in awareness	13	4.3
Case study	10	3.3
Education – comparing teaching curricula, improving academic skills, mainstreaming school-aged children, role of paraprofessionals	7	2.3

studies that recruited participants (n = 131, 60.9%), the majority of publications focused on seniors age 65 and over (n = 54, 41.2%), whereas 51 papers dealt with life span issues, 15 reported on findings in children and youth age 0-21, and 11 publications did not specify participants age.

Discussion

The purpose of this systematic review was to replicate the study by Teichman and Markowitz[3] under conditions of a systematic literature review. As pointed out by Teichman and Markowitz, LVR is a classic example for multidisciplinary collaboration, and this reality is reflected in the large variety of professions that publish in this area of research in a large variety of journals. Contrary to their findings that pointed to physicians being the largest group of research authors in LVR, the present data, under conditions of a systematic literature review, indicate that PhDs form the largest group of lead authors in this field (with or without a clinical degree). This would make intuitive sense since one of the professional goals of academics is to conduct and publish research, whereas the primary mandate of clinicians is to evaluate, treat and refer patients. The exception here may be clinician-scientists who hold both an academic and a professional degree, such as MD, PhD and OD PhDs, and who combine both their clinical and research efforts. Of particular interest is the group of authors with master's and bachelor's degrees only, many of whom represent professionals who also hold concurrent clinical degrees in areas such as occupational therapy, nursing or low vision rehabilitation, and who provide direct rehabilitation services to individuals with low vision. Their representation as first authors of research papers is considerable, given that it is an unlikely part of their clinical service delivery mandate to conduct and publish research, both time-consuming activities for a clinician. The group of master's degree authors also includes doctoral students who published components of their graduate work. This group is very small and this may be an indicator of how few students pursue graduate training in fields related to LVR. Given the projected demographic changes in developed countries and the associated impending retirement of professionals over the coming decades, this is a worrisome statistic and has previously been discussed in more detail.[7,8] It is the responsibility of current professionals to recruit, train and inspire the next generation of LVR researchers. Should we fail in this task, the future of LVR research could be bleak.

In concurrence with Teichman and Markowitz's results[3], this review found that the large majority of research (70.1%) was conducted in university settings. Given the involvement of academics and the distribution of universities across Canada, it was not surprising that Ontario and Quebec were the source of over 80 per cent of the published papers. Close to one-third of publications originated within the two schools of optometry. However, a closer look at the actual authors revealed that the most prolific author/co-author among the 215 studies was an ophthalmologist (n = 22 studies), followed by an experimental psychologist (n = 21), an OD (n = 17) and three OD PhDs (n = 17, 16 and 13).

Given the historical origins of LVR research, it is not surprising that a large number of research articles were published in journals such as JVIB that are geared towards rehabilitation professionals. The choice of publication venue may be driven by impact factor for academics, whereas publishing in clinician journals may be more likely to distribute research findings among those who are most likely to implement the results, thereby having the highest clinical impact. From the perspective of improving clinical practice, this is good news because the ability of knowledge transfer from research into practice is thereby facilitated. Here is also where the effect of the hand search during the systematic review became apparent. Practitioners' journals are less likely to have a quantifiable impact factor and are rarely indexed in library databases or electronically available, specifically for issues before the year 2000. However, those journals contributed 158 citations (69.8%) of the overall search results.

The large increase in publications over the last decade is promising. Given that LVR research is still a young area of investigation, much remains to be done. In order to make these research endeavours

feasible, however, funding will play an important role. The fact that 61.4 per cent of studies did not acknowledge any source of funding may be rooted in the reality that many studies in this field are simply not funded but are conducted by dedicated individuals, teams and institutions that are trying to find answers to clinically relevant questions. It is possible that some journals do not specifically ask for funding information, however, the funding agencies generally request that their contribution be acknowledged in resulting publications, and such credit usually improves the chances for future funding. It was surprising that of the funded studies, research consortiums (e.g. collaborations of private, hospital and/or university organizations) carried the largest financial load, supporting one-third of all papers. In many cases, small practice-based studies were funded by endowments or foundations based on a specific project. Federal and provincial governments provided support for 30 per cent and 19 per cent respectively, while industry funding was minimal, at 4.1 per cent. At the federal and provincial funding agency level, the field of LVR still has to improve its competitive edge and demonstrate its place among the health priorities.

The analysis of the publication content indicated that the main research priority was on service delivery (e.g. delivery models, employment and education strategies, information access, awareness). This makes intuitive sense, given the number of studies funded by agencies that may want to strategically streamline their services and become as efficient and effective as possible. The second-largest category was review papers, most of which were intended to inform clinicians as well as researchers about the current state of knowledge in the field. It should be noted that review papers rarely require extensive funding, making them more feasible in underfunded research areas. Publications on the psychosocial impact of low vision ranked third, dealing with common topics such as depression, coping strategies, anxiety, and life satisfaction. Intuitively, these studies are of interest for various stakeholders, given that the state of mind of the clientele greatly influences their perception of service delivery and uptake. The fourth-largest group of publications dealt with low vision-specific applied domains such as optics, psychophysical measurement of residual visual function and assistive technology. As pointed out by Teichman and Markowitz, the group of papers on assessment tools was small, at only 10 per cent, given that this area is of great importance for the field of low vision. The development and proper application of appropriate outcome measures in low vision research will determine how our domain is evaluated and compared to other rehabilitation fields.[9]

It is likely that the present data underestimate the contribution of any specific profession. In the case of LVR research in Canada, hosting the 9th International Conference on Low Vision – Vision 2008 in Montreal[10], or the fact that the editor-in-chief of the journal *Insight: Research and Practice in Visual Impairment and Blindness* is a Canadian[11] are not truly quantifiable. In addition, this systematic review does not include the grey literature, thereby neglecting non-peer-reviewed contributions. For example, Canada contributed 19 proceedings papers to Vision 2005 in London, England, and 54 papers to the proceedings of Vision 2008, of which 11 were published in French. None of these contributions are accounted for in this review. In addition, there are several methodological limitations and differences between this study and the one conducted by Teichman and Markowitz. The choice to limit the inclusion criteria in both studies to papers by first authors with an affiliation at a Canadian institution may have excluded papers by non-Canadians who conducted research within Canada or Canadians who conducted their work outside of the country. Additionally, the summary of author affiliations in this study was based on the first author whereas Teichman and Markowitz sorted their data by the corresponding author. The differences could in part be accounted for by laboratory leaders or supervisors (corresponding) versus students (first authors in case of supervised work), however, this difference is unlikely to affect the affiliations. Furthermore, the present study refined and limited the inclusion topics more strictly than the paper by Teichman and Markowitz. For example, studies that evaluated or developed measures also used in

low vision (such as visual field perimetry) when the manuscript did not include a low vision population, were excluded.

A general limitation of this study as well as the work by Teichman and Markowitz is that the quantitative evaluation of the number of publications is used as a proxy for estimating the leadership role in low vision rehabilitation research. This is, however, unlikely to be the case since quality has not been assessed. In order to bring more clarity to this question, a more traditional approach to systematic reviews, such as the one used by Jutai et al.[12] should be applied (this is currently under preparation). Such a study could focus on a detailed evaluation of research contributions, design quality, clinical relevance, as well as impact factors and citation frequency. What is clear, however, is that for LVR research to truly blossom and improve rehabilitation services, a collaborative spirit is required in which all rehabilitation-related professions work together in order to improve services for the visually impaired. Given what is known about the "demographic tsunami"[13]of older adults with vision loss the rehabilitation professions will be facing over the coming decades, it is only as a team that we will be able to provide the quality and type of services that will be required.

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