Home Lighting Assessment for Clients With Low Vision

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MeSH TERMS

- environment
- environment design
- home care services
- lighting
- vision, low

OBJECTIVE. The goal was to develop an objective, comprehensive, near-task home lighting assessment for older adults with low vision.

METHOD. A home lighting assessment was developed and tested with older adults with low vision. Interrater and test-retest reliability studies were conducted. Clinical utility was assessed by occupational therapists with expertise in low vision rehabilitation.

RESULTS. Interrater reliability was high (intraclass correlation coefficient [ICC] = .83–1.0). Test-retest reliability was moderate (ICC = .67). Responses to a Clinical Utility Feedback Form developed for this study indicated that the Home Environment Lighting Assessment (HELA) has strong clinical utility.

CONCLUSION. The HELA provides a structured tool to describe the quantitative and qualitative aspects of home lighting environments where near tasks are performed and can be used to plan lighting interventions. The HELA has the potential to affect assessment and intervention practices of rehabilitation professionals in the area of low vision and improve near-task performance of people with low vision.

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Approximately 2.4 million Americans have low vision, and the prevalence is likely to increase substantially over the next 20 yr (Congdon et al., 2004). *Low vision*, defined as a significant reduction in visual function that cannot be fully corrected with the use of eyeglasses, contact lenses, or medical treatment (Massof, 2006), is associated with common age-related eye conditions, including age-related macular degeneration (AMD) and glaucoma. The growing population of older adults with vision loss is at risk for decline in ability to perform daily activities required to age in place, in part because of suboptimal lighting.

The quality of an older adult's vision worsens because of typical aging processes and age-related vision disorders. Several of these age-related changes affect the amount of light that reaches the retina, including reduction in pupil size and scattering of light (Watson, 2001). By age 60, the lens transmits only 20% of light; the presence of cataracts may reduce light transmission to as low as 2% (Sadun & Libondi, 1990).

The Illumination Engineering Society of North America recommends lighting levels for a range of domestic tasks performed in a variety of locations in the home (IBACOS, 2013). Lighting levels are described in *lux*, a standard measure of illuminance, which is defined as the amount of light from a uniform source on a surface of 1 meter in radius (Merriam-Webster, n.d.). For example, a healthy adult age 55 or older requires a lighting level of approximately 540 lux to read small print for prolonged periods of time. Multiple studies show that home lighting levels are well below these recommended lighting levels (Charness & Dijkstra, 1999; Cullinan, Gould, Silver & Irvine, 1979; Levitt, 1978; Lindner, Rinnert, &

Behrens-Baumann, 2001). People with ocular disease may require even higher levels of properly directed light.

Study participants with AMD experienced improvements in near visual acuity and ability to detect low-contrast obstacles with lighting level increases from 300 to 5920 lux (Eldred, 1992; Haymes & Lee, 2006). Lighting-related issues for people with glaucoma include difficulties with glare and adaptation to different lighting levels (Nelson, Aspinall, & O'Brien, 1999). Cataracts may cause poor vision at night and difficulty with glare because of sunlight, headlights, and lamps (National Eye Institute, 2009). People with glaucoma, diabetic retinopathy, and cataracts may benefit from additional lighting that is properly directed to avoid problems with glare.

Benefits of Optimal Lighting

Increasing the amount of light has a significant positive effect on sentence reading acuity, reading rate, and critical print size for people with AMD (Bowers, Meek, & Stewart, 2001). Brunnström, Sörensen, Alsterstad, and Sjöstrand (2004) found that higher lighting levels led to improvement in selected instrumental activities of daily living and increased well-being. In addition, study participants were able to see and recognize more objects in a simulated living room setting with higher lighting levels (Cornelissen, Bootsma, & Kooijman, 1995) and, thus, may have been better able to avoid collisions and falls.

Despite the known benefits of lighting, older adults may not fully appreciate the role of lighting and rate home lighting as adequate when it is actually suboptimal (Bakker, Iofel, & Lachs, 2004). Moreover, improving lighting, contrast, and safety may be viewed by the client as less important than learning daily living skill strategies (Schuchard, Naseer, & de Castro, 1999).

Home Lighting Assessment and Occupational Therapy

Home environment assessment is a key component of the occupational therapy evaluation. Home lighting should be included in the home environment assessment for key reasons including that (1) the aging eye causes reduced amounts of light to reach the retina, (2) persons with ocular disease require significant increases in lighting, (3) some ocular diseases cause light sensitivity, and (4) home lighting is well below recommended levels. Each reason may cause unnecessary occupational performance limitations. In addition, Lindner and colleagues (2001) found that more than 70% (54/76) of study participants used ceiling lights rather than task lights as primary lighting

sources for reading, and only 40% used additional task lighting. Given that older adults spend an average of 12 to 16 hr, or 80% of their day, in their own homes (Horgas, Wilms, & Baltes, 1998), home lighting is a critical area for occupational therapists to address.

Lighting preferences are highly individual; thus, assessment approaches should include objective and subjective evaluations of visual comfort to determine optimal illumination (Bowers et al., 2001; Cornelissen et al., 1995; Valberg & Fosse, 2002). Several standard measures include items related to home lighting. The Housing Enabler has 180 items related to the physical home environment, two of which relate to outdoor lighting and illumination of walkways (Slaug, 2001). The Home Assessment of the Person–Environment Interaction–Visual Version includes assessment of quantity, position, and direction of lighting, glare, color, contrast, and light changes with day, night, or season, but it is only available in French (Carignan, Rousseau, Gresset, & Couturier, 2008). The Craig Hospital Inventory of Environmental Factors is a 25-item questionnaire used to identify environmental barriers to participation that was initially created for use in the general population (Harrison-Felix & Mellick, 2001; Whiteneck et al., 2004). The measure was standardized for individuals with low vision, but lighting is assessed only in broad terms. The Home Occupation–Environment Assessment is a measure of home safety and includes items related to physical accessibility, sanitation, proper food storage, general safety, and lighting levels at the point of task (Baum & Edwards, 1998).

Lighting levels are measured with a light meter at the location where the person reads, pays bills, and prepares meals and at other locations. With the exception of the Home Assessment of the Person–Environment Interaction–Visual Version, none of these home environment assessments focuses on lighting at the level required to plan home lighting intervention for people with low vision.

State of Lighting Assessment and Intervention in Home Health and Low Vision

Before embarking on the development of a specific home lighting assessment, we sought to determine the state of current occupational therapy practice in terms of home lighting assessment and intervention. Our literature review confirmed the contribution of lighting to visual function and safety, but it appeared that lighting was not consistently addressed by rehabilitation professionals who work with older adults or low vision professionals. To further explore this topic, we surveyed 190 occupational therapists who work in home health, low vision rehabilitation, or

both, to determine how they addressed lighting in their respective practices (Gendeman, Perlmutter, & Baum, 2010). The survey results indicate that 10% (20/190) used standardized home evaluation measures, whereas 37% (70/190) used agency-based measures. Moreover, only 4% (8/190) used a light meter. Clearly, an occupational therapy home lighting assessment that includes comprehensive objective approaches is needed.

Evidence Guiding Components of Home Lighting Assessment

The literature provides evidence that certain components should be incorporated into a home lighting assessment. An obvious element is an objective measure of illumination, such as light meter readings. Recommended levels of illumination are provided by the Illumination Engineering Society of North America, and the literature guides us regarding optimal levels for specific diagnoses, such as AMD (Eldred, 1992; Haymes & Lee, 2006). Glare intolerance and sources of direct and indirect glare should be included in a home lighting assessment because glare reduces visual comfort and can be controlled with use of filters (S. N. Markowitz, 2006), window treatments, and covering of reflective table and counter tops. Assessment of seating arrangement and positioning of reading material must be considered (M. Markowitz, 2006) because modifications of these features can be suggested to optimize benefit from lighting.

Studies related to the subjective nature of lighting preferences guide inclusion of assessment of qualitative aspects and comfort with the lighting environment. Four of the 18 study participants in Eldred's (1992) study experienced discomfort and eye strain with use of high illumination levels for prolonged periods of time. Bowers et al. (2001) found that the ideal level of lighting determined by objective means was higher than levels determined by subjective preference, most likely because of greater visual comfort. The qualitative experience of the lighting environment can be determined by asking questions that address eye strain, ability to tolerate prolonged periods of reading or other near-task activity, comfort level, and satisfaction with the lighting environment. Barstow, Bennett, and Vogtle (2011) agreed that lighting, glare, and compensation strategies should be included in home assessments geared for older adults with vision loss.

Purpose

The purpose of this project was to develop a comprehensive, objective near-task home lighting assessment that

(1) is reliable and valid, (2) has clinical utility for occupational therapists in low vision rehabilitation and home health, and (3) may be used as an outcome measure in a lighting modification efficacy study.

Method

Design

The initial development and refinement of the Home Environment Lighting Assessment (HELA) occurred through a three-stage process. In Stage 1, the initial version of the HELA was developed and tested with persons with glaucoma. In Stage 2, a revised version of the HELA was administered to individuals with macular degeneration, and a clinical utility study was conducted. Minor revisions were made following this trial. Stage 3 was designed to determine interrater and test-retest reliability. Discussion of each development stage follows the instrument description. This study received institutional review board approval, and all participants provided consent.

Instrument Description

The current form of the HELA includes key components identified in the literature and is arranged in four sections (Table 1). In Part 1, the preintervention section, the lighting environment is described, including illumination sources, client seating arrangement, position of reading material, window treatments, and influence of glare and outdoor lighting, using a check box format. A light meter reading is taken as well as a digital photo. The MNRead Low Vision Reading Acuity Chart is administered before making lighting modifications to obtain a baseline of reading acuity and critical print size with current illumination (Legge, Ross, Luebker, & LaMay, 1989). Questions regarding the qualitative experience with the current lighting environment, such as eye strain, length of time the person can read, and enjoyment of the lighting environment, are posed and responded to by using a 4-point scale.

Part 2 includes a list of potential lighting interventions, such as recommendation of using a table or floor lamp, changing the light wattage or lamp shade, and repositioning reading material. It serves as a prompt for occupational therapy practitioners to consider as they plan modifications.

Part 3 is the postintervention section. A light meter reading and photo are taken of the modified lighting, and an alternative form of the MNRead is administered to determine whether changes in reading acuity occurred with modified lighting.

Table 1. Home Environment Lighting Assessment (HELA)

HELA Sections	Content
Preintervention	<ul style="list-style-type: none"> • Description of the lighting environment <ul style="list-style-type: none"> — Illumination sources and position — Client seating arrangement — Position of reading material — Window treatments and outdoor lighting — Influence of glare • Light meter assessment • Photo (optional) • MNRead (Chart 1) • Quality of near-task experience <ul style="list-style-type: none"> — Eye strain with current lighting — Overall satisfaction
Lighting intervention	<ul style="list-style-type: none"> • Check box format of lighting modifications and comments <ul style="list-style-type: none"> — Change wattage of lightbulb — Change position of lamp or fixture — Provide additional lamp — Educate in glare reduction methods
Postintervention	<ul style="list-style-type: none"> • Light meter assessment • Photo (optional) • MNRead (Chart 2)
Lighting Modification Satisfaction Survey	<ul style="list-style-type: none"> • Are modifications still in place and in use? • Are there barriers to lighting modification implementation? • Is task easier or more enjoyable with new lighting? • Did you make additional lighting changes?
Summary table	<ul style="list-style-type: none"> • Preintervention and postintervention light meter readings • Preintervention and postintervention MNRead results

Part 4 includes the Lighting Modification Satisfaction Survey, which can be used immediately postintervention, at discharge, or 3 to 5 wk postintervention through a phone call. The client is asked whether the lighting modifications are still in place and in use and whether barriers to implementation existed. The questions about the quality of lighting experience are posed with respect to the modified lighting. A summary table of the pre- and postintervention lighting levels and MNRead scores is provided for client education purposes. A complete copy of the HELA is available at www.ot.wustl.edu.

Initial Stages of the Development of the HELA

Stage 1: Preliminary Version Trial. The original version of the HELA was used on a trial basis with 11 participants. The inclusion criteria included age at least 55 yr but not older than 90 yr, diagnosis of glaucoma or no ocular disease, and ability to use residual vision to read 8M print size. Exclusion criteria included declines through written consent and dwelling in nursing home or assisted care facility at the time of recruitment or study visit. Three

study participants had no ocular disease, 3 had moderate glaucoma, and 5 had severe glaucoma according to the Glaucoma Staging System (Mills et al., 2006).

The participants were randomized into control and intervention groups to determine how the HELA performed with older adults with and without ocular disease. All study participants and lighting environments were evaluated pre- and postintervention by using the HELA in one home visit. The control group received a placebo lightbulb change of the same wattage in the locations in the home where they read and paid bills. The intervention group received individualized lighting modifications, including change in wattage, change in position of lighting fixture or lamp shade, glare reduction methods, and positioning of reading material in the locations where they read and paid bills, completed correspondence, or both.

Stage 2: Revised Version Trial and Clinical Utility Study.

The HELA was revised and used with 9 participants with AMD. The remaining inclusion and exclusion criteria were the same as those used in the original trial. We determined that it would be useful to provide lighting intervention to all participants in this sample so we could gain further experience with the postintervention portion of the HELA; thus, control and intervention groups were not used in this stage. All participants received near-task lighting intervention and modifications.

In addition, 5 occupational therapists with expertise in low vision rehabilitation were trained through webinar and teleconferencing to administer the revised version of the HELA. Four of the 5 occupational therapists administered the HELA to 5 clients; 1 occupational therapist administered the HELA to 2 clients. A Clinical Utility Feedback Form was created on the basis of key elements of clinical utility, including availability, ease of use, administration time, “learnability,” format, scoring, and meaningfulness and relevance of information derived (Law, King, & Russell, 2001). Each of the 11 items was rated using a 5-point Likert scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). The occupational therapists and the research team completed the feedback form and provided suggestions for revision as well.

Item and format refinements that resulted from this phase included creating one form for use with near-task activities applicable to any client, using check box options for the lighting description and window treatment sections, and adding scripts to some portions.

Stage 3: Interrater and Test–Retest Reliability Pilot Study.

To establish interrater reliability, the first author (Perlmutter) administered the HELA to 5 study participants with a variety of low vision diagnoses. This study visit occurred in the participant’s home during daylight hours between

9 a.m. and 4 p.m. Each testing session and postintervention survey was videotaped. After completion of the study visits, the first author and four trained occupational therapist graduate students reviewed the videotapes and simultaneously scored the HELA.

Test-retest reliability of the HELA was determined by creating consistent environments in the interior spaces of the Washington University Program in Occupational Therapy. Lighting Environment 1 was located in an office setting and included a table lamp with incandescent bulb centered in the work area. The study participant was seated in a chair at a desk. Lighting Environment 2 was located in the Activities of Daily Living Lab bedroom. A table lamp with an incandescent bulb was placed on a bedside table to the left of the participant. The study participant was asked to read while lying on the bed. The first author rated all study participants in both environments; the Lighting Modification Satisfaction Survey was administered immediately after the postintervention portion. Time 1 and Time 2 were separated by 1 to 2 wk.

Data Analysis

For Stage 1, means and ranges for pre- and postintervention light meter readings, MNRead reading acuity, and critical print size scores were calculated. A one-tailed paired *t* test was used to determine significance. To determine clinical utility, we averaged ratings assigned by the research team members and low vision occupational therapists for each Clinical Utility Feedback Form item. For the reliability study, variables that required interpretation by the rater were selected for analysis. These items included those from the lighting description, lighting intervention, and quality-of-lighting experience portions of the HELA. The qualitative lighting experience variables in the preintervention portion and the Lighting Modification Satisfaction Survey were combined for analysis. Data were entered into SPSS Version 20 software (IBM Corporation, Armonk, NY). Intraclass correlation coefficients (ICCs) were used to assess inter-rater and test-retest reliability (Portney & Watkins, 2009, p. 590).

Results

Twenty-five study participants were included. In Stage 1 of the development of the HELA, 3 study participants had no ocular disease, and 8 had glaucoma. Seven were women, and the mean age was 71 yr. In Stage 2, 9 participants with AMD were included. Eight were women; the mean age was 74. In Stage 3, 5 women with various low vision diagnoses and mean age of 74 were tested. All

25 participants resided in the community, and all participants were retired except for 1 participant included in Stage 2 who worked full time.

Stage 1: Development of the HELA

In Stage 1, we found statistically significant increases in lighting levels (measured in lux) postintervention for the intervention group in both the reading and bill paying locations (Table 2). There were no significant changes in lighting levels for the control group or visual function scores for the control and intervention groups following intervention. However, participants in the intervention group provided unsolicited comments that the lighting modifications resulted in reduced eye strain, ability to read or pay bills for longer periods of time, and increased enjoyment. This pilot experience demonstrated the value of using a light meter and prompted the addition of questions geared toward the qualitative aspects of lighting. In addition, results of our initial experience led to combining sections, changing the sequencing of some items, adding light source options, and revising the glare-related items.

Stage 2: Revisions and Clinical Utility of the HELA

Item and format refinements that resulted from this phase included combining the reading and bill-paying sections to make one form for use with near-task activities applicable to any client, creating a table with check box options for the lighting description and window treatment sections, clarifying the glare items, and adding scripts to some portions. The photo was made optional because some participants were reluctant to have their picture

Table 2. Lighting Levels Pre- and Postintervention

Variable	Lux, <i>M</i> ± <i>SD</i>	Range
Intervention Group		
Reading location ^a		
Lighting preintervention	380.09 ± 153.43	131–616
Lighting postintervention	1151.71 ± 1246.96	237–3669
Bill-paying location ^b		
Lighting preintervention	391.17 ± 206.06	179–519
Lighting postintervention	1130.86 ± 866.02	152–2240
Control Group		
Reading location ^c		
Lighting preintervention	329.00 ± 58.12	131–408
Lighting postintervention	380.85 ± 163.80	152–586
Bill-paying location ^d		
Lighting preintervention	486.50 ± 99.70	416–557
Lighting postintervention	546.50 ± 55.86	152–586

Note. *M* = mean; *SD* = standard deviation.
^a*p* = .045. ^b*p* = .018. ^c*p* = .21. ^d*p* = .34.

taken, and the lighting intervention section was converted to a check box format.

Five occupational therapists who were working in low vision rehabilitation settings across the country administered the HELA to 22 clients and rated the HELA's clinical utility based on this experience. In addition, the Washington University Occupational Therapist research team rated the HELA using the Clinical Utility Feedback Form. Ratings assigned by the research team members and low vision occupational therapists for all Clinical Utility Feedback Form items were averaged. The research team and low vision occupational therapist averages ranged from 3.0 to 4.0, indicating that all raters agreed or strongly agreed that the HELA has strong clinical utility across all key components (Table 3).

Stage 3: Reliability of the HELA

The ICCs ranged from .83 to 1.0. All 5 raters had perfect agreement for the lighting environment description checklist portion; thus, the ICC value was 1.0. ICC ranges for the lighting description and quality-of-lighting experience items subsections were .83–1.0 and .95–1.0, respectively. The variance of responses for some items was so low that it violated the assumptions of the ICC. Therefore, it was arithmetically impossible to compute the ICC statistic. The ICC value for test–retest reliability was .67.

Discussion

Existing home environment assessments do not fully address the lighting needs of people with vision loss. The development of the HELA was based on literature-supported lighting elements known to affect people with low vision. This new measure provides an objective and comprehensive approach to assessing near-task lighting for older adults with age-related vision loss and has potential to be

useful with persons who have other forms of vision loss and presbyopia.

Interrater Reliability

Interrater reliability coefficients met our criterion of .75 for individual rater reliability for all items. The ICCs obtained for the lighting description section of the HELA were slightly lower than the quality-of-lighting experience and lighting intervention items, perhaps because of rater error when describing light fixtures. This level of interrater reliability was achieved with a group of master's and doctoral occupational therapy students who were trained but did not have much clinical experience, suggesting that the HELA is relatively easy to learn to administer and appropriate for novice clinicians.

Test–Retest Reliability

The ICC for test–retest reliability was moderate at .67. A combination of factors may account for this result; 2 participants had difficulty remembering the quality-of-lighting experience questions and responses immediately after they were asked; thus, their responses were inconsistent. Large-print response cards will be developed to address this concern. Variability in participant-related factors between Visits 1 and 2, such as eye strain, comfort level, and preferences for lighting fixtures, may have occurred. Finally, rater error may have occurred on a minimal level.

Clinical Utility

Feedback from the research team and experienced occupational therapists in regard to the clinical utility of the HELA was positive. The two aspects of clinical utility receiving the lowest averaged ratings were “ease and efficiency of use” and “clear and easy format.” The HELA offers

Table 3. Clinical Utility Feedback Form Ratings

Clinical Utility Components	Average Ratings	
	Research Team	Occupational Therapists
Readily available materials	4.00	3.75
Reasonable cost	3.80	4.00
Ease and efficiency of use	3.00	3.00
Clear and easy format	3.20	3.50
Reasonable administration time	3.40	3.75
Ease of learning to administer	3.80	4.00
Novice could learn to use	4.00	4.00
Client receptiveness to evaluation	4.00	3.50
Provided objective and comprehensive information	4.00	3.25
Objectiveness and comprehensiveness compared with current lighting assessment being used	4.00	3.25
Information was meaningful and assisted in lighting modification and client education	3.80	3.50

Note. Each item was rated on a 5-point Likert scale ranging from 0 (strongly disagree) to 4 (strongly agree).

a comprehensive approach to home lighting assessment and likely makes the home evaluation process a bit more time consuming; formatting suggestions were incorporated to improve ease of use and flow. Comments from the experienced occupational therapists indicated that the HELA is an objective, systematic home lighting assessment that fosters a more comprehensive approach to intervention than current approaches. In addition, the clinicians reported that the objective nature of the light meter reading motivated their clients and promoted readiness for lighting modifications.

Limitations

The study has a number of limitations. Interrater and test-retest reliability were examined with a small convenience sample of 5 women. Although the interrater reliability coefficients met our criterion of .75, we found instances of rater error, indicating possible need for refinement of the HELA or additional training. Test-retest reliability was determined by use of one rater. The clinical utility portion of the study was completed with 5 occupational therapists with low vision rehabilitation expertise; the HELA will need to be used and evaluated by a broader group of occupational therapists who work in low vision and with older adults to further determine clinical utility. The HELA is limited to assessment of lighting in locations where near tasks are performed and does not include assessment of overall room lighting and stairwells needed for mobility, nor does it assess contrast. Practitioners who desire a fully comprehensive home lighting assessment may view this as a limitation as well.

Future Directions

In the preliminary stage of its development, the HELA showed high reliability and strong clinical utility; however, additional refinement is needed. Future efforts to refine the HELA should include a larger sample of older adults with low vision and use of multiple raters to further establish test-retest reliability. Long-term goals include use of the HELA to study the efficacy of client-centered home lighting intervention and determining its utility with a general older adult population.

Implications for Use in Occupational Therapy Practice and Research

The HELA shows promise as a reliable near-task home lighting evaluation tool that has demonstrated clinical utility. ICCs ranged from .83 to 1.0, indicating strong interrater reliability. Test-retest reliability was moderate

(ICC = .67). Positive clinical utility ratings were based on the experience of 5 occupational therapists administering the HELA to 22 clients in their low vision rehabilitation practices as well as the research team's experience with the measure.

The HELA has the potential to advance the current state of home lighting assessment and affect assessment and intervention practices of low vision rehabilitation professionals and near-task performance of clients with low vision. Implications for practice are as follows:

- The HELA enables practitioners to assess the quantitative and qualitative aspects of the home lighting environment.
- The checklist format of the lighting intervention section offers the clinician a guide for planning lighting modifications.
- Use of the MNRead or the Colenbrander Mixed Contrast Reading Card (Colenbrander & Fletcher, 2004), in conjunction with the HELA, allows for objective assessment of reading acuity pre- and postintervention. Although performance on the MNRead before and after intervention was not the focus of our efforts, we found that most of our participants experienced some degree of improvement in reading acuity, critical print size, or both as a result of lighting changes. Sharing information of this nature with clients may have a positive impact on their receptivity to lighting modifications.

Finally, the HELA could be used as an outcome measure in future studies designed to evaluate the efficacy of home lighting modifications. The majority of lighting studies related to the low vision population focus on measuring the benefit of increasing light levels in controlled environments (Bowers et al., 2001; Brunnström et al., 2004; Cornelissen et al., 1995). Studies that examine the impact of a home-based, client-centered, multifaceted approach to lighting intervention are needed. The impact of lighting changes on the qualitative experience of lighting environments should be assessed as well. For some older adults with low vision, the goal of lighting improvements may be to read or cross-stitch for longer periods of time or with less eye strain. Studies of this nature would reflect the way in which occupational therapists address the effects of the environment on occupational performance, participation, and quality of life. ▲

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References

- Bakker, R., Iofel, Y., & Lachs, M. S. (2004). Lighting levels in the dwellings of homebound older adults. *Journal of Housing for the Elderly*, 18, 17–27. http://dx.doi.org/doi:10.1300/J081v18n02_03
- Barstow, B. A., Bennett, D. K., & Vogtle, L. K. (2011). Perspectives on home safety: Do home safety assessments address the concerns of clients with vision loss? *American Journal of Occupational Therapy*, 65, 635–642. <http://dx.doi.org/doi:10.5014/ajot.2011.001909>
- Baum, C. M., & Edwards, D. F. (1998). *Guide for the Home Occupation–Environment Assessment*. St. Louis, MO: Washington University Program in Occupational Therapy.
- Bowers, A. R., Meek, C., & Stewart, N. (2001). Illumination and reading performance in age-related macular degeneration. *Clinical and Experimental Optometry*, 84, 139–147. <http://dx.doi.org/doi:10.1111/j.1444-0938.2001.tb04957.x>
- Brunnström, G., Sörensen, S., Alsterstad, K., & Sjöstrand, J. (2004). Quality of light and quality of life—The effect of lighting adaptation among people with low vision. *Ophthalmic and Physiological Optics*, 24, 274–280. <http://dx.doi.org/doi:10.1111/j.1475-1313.2004.00192.x>
- Carignan, M., Rousseau, J., Gresset, J., & Couturier, J. A. (2008). Content validity of a home-based person–environment interaction assessment tool for visually impaired adults. *Journal of Rehabilitation Research and Development*, 45, 1037–1051. <http://dx.doi.org/doi:10.1682/JRRD.2007.10.0158>
- Charness, N., & Dijkstra, K. (1999). Age, luminance, and print legibility in homes, offices, and public places. *Human Factors*, 41, 173–193. <http://dx.doi.org/doi:10.1518/001872099779591204>
- Colenbrander, A., & Fletcher, D. C. (2004). Evaluation of a new mixed contrast reading card. *Investigative Ophthalmology and Visual Sciences*, 45, E-Abstract 4352.
- Congdon, N., O'Colmain, B., Klaver, C., Klein, R., Muñoz, B., Friedman, D. S., . . . Mitchell, P.; Eye Diseases Prevalence Research Group. (2004). Causes and prevalence of visual impairment among adults in the United States. *Archives of Ophthalmology*, 122, 477–485. <http://dx.doi.org/doi:10.1001/archophth.122.4.477>
- Cornelissen, F. W., Bootsma, A., & Kooijman, A. C. (1995). Object perception by visually impaired people at different light levels. *Vision Research*, 35, 161–168. [http://dx.doi.org/doi:10.1016/0042-6989\(94\)00183-M](http://dx.doi.org/doi:10.1016/0042-6989(94)00183-M)
- Cullinan, T. R., Gould, E. S., Silver, J. H., & Irvine, D. (1979). Visual disability and home lighting. *Lancet*, 313, 642–644. [http://dx.doi.org/doi:10.1016/S0140-6736\(79\)91082-1](http://dx.doi.org/doi:10.1016/S0140-6736(79)91082-1)
- Eldred, K. B. (1992). Optimal illumination for reading in patients with age-related maculopathy. *Optometry and Vision Science*, 69, 46–50. <http://dx.doi.org/doi:10.1097/00006324-199201000-00007>
- Gendeman, J., Perlmutter, M., & Baum, M. C. (2010). *Lighting assessment and intervention: The state of current practice*. Washington University Program in Occupational Therapy Scholar Day, St. Louis, MO.
- Harrison-Felix, C. L., & Mellick, D. C. (2001). *Craig Hospital Inventory of Environmental Factors* (Version 3.0). Retrieved from www.craighospital.org/Research/CHIEF%20Manual.pdf
- Haymes, S. A., & Lee, J. (2006). Effects of task lighting on visual function in age-related AMD. *Ophthalmic and Physiological Optics*, 26, 169–179. <http://dx.doi.org/doi:10.1111/j.1475-1313.2006.00367.x>
- Horgas, A. L., Wilms, H. U., & Baltes, M. M. (1998). Daily life in very old age: Everyday activities as expression of successful living. *Gerontologist*, 38, 556–568. <http://dx.doi.org/doi:10.1093/geront/38.5.556>
- IBACOS. (2013). *Illumination Engineering Society of North America guidelines*. Retrieved from www.ibacos.com/high-performance-lighting-guide/iesna-guidelines
- Law, M., King, G., & Russell, D. (2001). Guiding decisions about measuring outcomes in occupational therapy. In M. Law, C. M. Baum, & W. Dunn (Eds.), *Measuring occupational performance: Supporting best practice in occupational therapy* (pp. 31–40). Thorofare, NJ: Slack.
- Legge, G. E., Ross, J. A., Luebker, A., & LaMay, J. M. (1989). Psychophysics of reading: The Minnesota Low-Vision Reading Test. *Optometry and Vision Science*, 66, 843–853. <http://dx.doi.org/doi:10.1097/00006324-198912000-00008>
- Levitt, J. G. (1978, April). *Lighting for the elderly: An optician's view*. Paper presented at the Symposium on Light for Partial Sight, Illuminating Engineering Society and Partially Sighted Society, London.
- Lindner, H., Rinnert, T., & Behrens-Baumann, W. (2001). Die Beleuchtung des Leseplatzes im privaten Wohnbereich Sehbehinderter: Eine klinische Studie an 91 Sehbehinderten [Illumination conditions of visually impaired people under private domestic circumstances—Clinical study on 91 patients]. *Klinische Monatsblätter für Augenheilkunde*, 218, 774–781. <http://dx.doi.org/doi:10.1055/s-2001-19688>

- Markowitz, M. (2006). Occupational therapy interventions in low vision rehabilitation. *Canadian Journal of Ophthalmology*, 41, 340–347. <http://dx.doi.org/doi:10.1139/I06-020>
- Markowitz, S. N. (2006). Principles of modern low vision rehabilitation. *Canadian Journal of Ophthalmology*, 41, 289–312. <http://dx.doi.org/doi:10.1139/I06-027>
- Massof, R. (2006). *Low vision and blindness: changing perspective and increasing success*. Retrieved from <https://nfb.org/images/nfb/publications/bm/bm06/bm0610/bm061005.htm>
- Merriam-Webster. (n.d.). Lux. In *Merriam-Webster's online dictionary*. Retrieved from <http://www.merriam-webster.com/dictionary/lux?show=0&t=1373217003>
- Mills, R. P., Budenz, D. L., Lee, P. P., Noecker, R. J., Walt, J. G., Siegartel, L. R., . . . Doyle, J. J. (2006). Categorizing the stage of glaucoma from pre-diagnosis to end-stage disease. *American Journal of Ophthalmology*, 141, 24–30. <http://dx.doi.org/doi:10.1016/j.ajo.2005.07.044>
- National Eye Institute. (2009). *Facts about cataract*. Retrieved from www.nei.nih.gov/health/ataract/ataract_facts.asp#3a
- Nelson, P., Aspinall, P., & O'Brien, C. (1999). Patients' perception of visual impairment in glaucoma: A pilot study. *British Journal of Ophthalmology*, 83, 546–552. <http://dx.doi.org/doi:10.1136/bjo.83.5.546>
- Portney, L. G., & Watkins, M. P. (2009). *Foundations of clinical research: Applications to practice*. Upper Saddle River, NJ: Prentice Hall.
- Sadun, A. A., & Libondi, T. (1990). Transmission of light through cataracts. *American Journal of Ophthalmology*, 110, 710–712.
- Schuchard, R. A., Naseer, S., & de Castro, K. (1999). Characteristics of AMD patients with low vision receiving visual rehabilitation. *Journal of Rehabilitation Research and Development*, 36, 294–302.
- Slaug, B. (2001). *Enabler FAQ*. Retrieved from www.enabler.nu/
- Valberg, P., & Fosse, A. (2002). Binocular contrast inhibition in subjects with age-related AMD. *Journal of the Optical Society of America A: Optics, Image Science, and Vision*, 19, 223–228. <http://dx.doi.org/doi:10.1364/JOSAA.19.000223>
- Watson, G. R. (2001). Low vision in the geriatric population: Rehabilitation and management. *Journal of the American Geriatrics Society*, 49, 317–330. <http://dx.doi.org/doi:10.1046/j.1532-5415.2001.4930317.x>
- Whiteneck, G. G., Harrison-Felix, C. L., Mellick, D. C., Brooks, C. A., Charlifue, S. B., & Gerhart, K. A. (2004). Quantifying environmental factors: A measure of physical, attitudinal, service, productivity, and policy barriers. *Archives of Physical Medicine and Rehabilitation*, 85, 1324–1335. <http://dx.doi.org/doi:10.1016/j.apmr.2003.09.027>