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# Illuminance Levels in Social Spaces of an Older Adult Facility

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## Abstract

As the population of the United States ages, one of the concerns is the growing demand for long-term care facilities. Appropriate lighting can improve the older adults' quality of life, maximize their personal independence, and promote health, well-being, and safety. The purpose of this study was to examine light levels at an existing continuing care retirement center (CCRC) to determine compliance with Illuminating Engineering Society (IES) recommendations. Addressing the needs of older adults in CCRCs is important as CCRCs' ultimate goal is to promote and protect the health, well-being, and satisfaction of their residents. Properly addressing lighting issues relevant to the older population can help to sustain their well-being. Convenience sampling was utilized to select one existing operational CCRC site in the south central United States of America. Lighting measurements were taken at the CCRC in six interior locations: 1) Lobby, 2) Hallway, 3) Dining Room, 4) Activity Room, 5) Chapel, and 6) Natatorium. Researchers measured 2'-0" or 4'-0" square grids on room surfaces using masking tape to create a grid as a visual aid for taking regularly spaced lighting measurements. Beginning at 12:30 pm and ending at 6:00 pm, the researchers visited the selected interior social spaces and measured the existing illuminance levels following industry-recommended procedures. The researchers measured the visible light in footcandles (fc) with a General Electric (GE) lighting model 217 "triple range" light meter. After taking multiple spot readings throughout each area according to industry recommendations, the means for each social space's light levels were calculated. In this field study, some or all of the light levels that were measured within four (67%) of the examined CCRC's social spaces were found to be lower than the specific industry lighting recommendations for the tasks expected to be performed in these areas when one considers the specific standards for older adults. Interior lighting in social spaces in CCRCs should be designed to support older adult residents in performing a range of visual tasks. Some existing lighting levels measured in the studied CCRC's social spaces did not meet industry illuminance recommendations. The studied facility is over 20 years old and could benefit from a lighting renovation. The non-uniform illumination found at the CCRC's facilities create potentially problematic areas of high light level contrasts with glare and deep shadows in evidence. This study could prove useful for designers of new facilities, and ultimately benefit older adults and their quality of life.

## Keywords

Lighting, Older Adults, Continuing Care Retirement Center, Social Spaces

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## 1. Introduction

Light can illuminate environments, enhance socialization and ensure safe mobility. According to the Illuminating Engineering Society (IES), lighting can play an important

role in meeting the challenges of older adults' physical conditions, such as eye diseases and changes in vision. Appropriate lighting can improve the older adults' quality of life and maximize their personal independence while promoting health, well-being, and safety [11]. Some authors have examined the way older adults' see under different

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lighting conditions [3]; researchers have chronicled age-related changes in vision and their resulting lighting needs [15]; others have indicated that lighting may affect the moods of older adults [10] and others have attempted to make recommendations for lighting conditions for older adult facilities [2] and residences [13]. The IES recommends that facilities designed for older adults view good lighting as a preventative measure and give priority consideration to facilities' lighting [11].

As the population of the United States ages, one of the major consequences is the growing demand for long-term care facilities. One facility type, known as continuing care retirement centers (CCRC), is targeted towards older adults and has become increasingly popular. This facility type accommodates the needs of older adults through various life stages. In a CCRC, these stages may include independent living, assisted living and nursing care [16]. As an alternative housing option for older adults, a CCRC offers different kinds of living units, activities, and services suited to individuals' health and social needs [17]. In addition to congregate housing, CCRCs usually contain activity spaces for older adult groups. Group activity areas provide for support and socialization and these spaces may include public circulation areas (i.e. hallways), gathering spaces (i.e. lobbies), dining rooms, shops, fitness centers, swimming pools, and worship areas (i.e. chapels). Addressing the needs of older adults in CCRCs is important as CCRCs' ultimate goal is to promote and protect the health, well-being, and satisfaction of their residents. Although people of various ages may sometimes require support from their environment in their daily lives, older adults often have special needs. One special need may be with regards to vision. Proper lighting may enhance vision for various activities [9; 12].

However, appropriate lighting solutions for older eyes are more complicated than the lighting solutions required for younger eyes due to the need to compensate for the age-related changes often occurring in the eyes [14]. Potential lighting design solutions differ in their abilities to support older adults' vision [12]. Published research examining the social areas' lighting in CCRC interiors is sparse. When providing lighting for future facilities which house older adults, it may be useful to examine existing facilities and identify problems with interior lighting in the social spaces at CCRCs.

Properly addressing lighting issues relevant to the older population will help to sustain their well-being [14]. Therefore, the purpose of this study was to examine light levels (*illuminance*) at an existing CCRC to determine compliance with IES recommendations. In this study, independent living residents are defined as those who do not require regular assistance in the performance of daily

activities, (i.e. eating, bathing and dressing).

### 1.1. Research Significance

This study is important and relevant because the older adult population is growing and CCRCs are becoming more common. More in situ case studies, such as this current field research project, are needed to expand the dearth of scholarly literature regarding illumination levels for older adults, and specifically for CCRCs. For a good quality of life, lighting levels for older adults need to be higher than those for the general population due to the tendency towards older adults' eye-related vision changes. The current research showed that many of the existing light levels at the studied site do not meet the recommendations for older adults. A CCRC with less-than-recommended levels in social areas could result in inconvenience, lower quality of life, slips and falls, collisions, injuries, and lawsuits. Knowledge of the industry-recommended levels should aid lighting designers, engineers, facility managers, CCRC administrators and most importantly, CCRC residents.

### 1.2. Older Adults' Vision and Social Spaces

The eyes experience changes with aging. Typically, with advancing age, the tissues of the eyes become more fragile, and the pupils become smaller. Older adults may need higher light levels to compensate [11]. Generally, proper illumination for older adults helps to ensure that people have sufficient illumination to perform *visual tasks* in a safe and effective manner [9]. Visual tasks in a CCRC's social spaces may include walking through the building entries, hallways, and lobby, as well as the performance of reading and other visually intensive activities. Additionally, pastimes such as accessing a swimming pool and conversing while dining may be considered visual tasks. Furthermore, obvious shadows in dining rooms should be avoided [1]. Shadows may negatively influence facial recognition and may cause confusion in a space where resident interaction is anticipated.

In addition, lighting design directly impacts older adults' *quality of life* [14]. "Quality of life experiences (are)...expressed in their perceptions, evaluations, and satisfactions..." [4]. Some researchers found a close relationship between lighting and quality of life in relation to older people [20]. They also suggested that lighting for older adults be studied and improved.

## 2. Procedure

### 2.1. Industry Recommendations for Illuminance

Industry illuminance level recommendations, for spaces intended mostly for use by older adults, are substantially

higher than those for similar spaces intended for the “general population” [18]. Comparisons between the older adults and general population recommendations made by the IES for visual tasks’ light levels [11; 18] that the researchers determined were applicable for six social interior spaces studied are shown in Table 1.

**Table 1.** IES visual tasks’ minimum illuminance levels\*.

| Activity   | Recommended illumination<br>General population |        |
|--|--|--------|
|  | (footcandles)                                  | (lux)  |
| Public spaces*   | 3*   | 32.29  |
| Simple orientation for short visit*  | 5*   | 53.82  |
| Working spaces where simple visual tasks are performed*  | 10*  | 107.64 |
| Performance of visual tasks of high contrast and large size*   | 30*  | 322.92 |
| Performance of visual tasks of high contrast and small size, or visual tasks of low contrast and large size” * | 50*  | 538.20 |

\* [18]

## 2.2. Sampling

Convenience sampling was utilized to select one existing operational CCRC site in the south central United States of America. Lighting measurements were taken at the following interior locations: 1) Lobby, 2) Hallway, 3) Dining Room, 4) Activity Room, 5) Chapel, and 6) Natatorium.

Researchers measured 2’-0” or 4’-0” square grids on room surfaces using masking tape to create a grid as a visual aid for taking regularly spaced lighting measurements. Beginning at 12:30 pm and ending at 6:00 pm, the researchers visited the selected interior social spaces and measured the existing illuminance levels following industry-recommended procedures. Figure 1 shows temporary grid marks placed by the researchers in the Hallway to aid in identifying measurement locations for light meter readings. The researchers measured the visible light in footcandles (fc) with a General Electric (GE) lighting model 217 “triple range” light meter. The researchers recorded these illumination measurements for the selected interior social spaces at the CCRC and also converted the footcandles to lux using the “Footcandles to Lux Conversion Calculator” found at rapidtables.com. Figure 2 shows the researchers recording the light meter readings measured in the Lobby. After taking multiple spot readings throughout each area according to industry recommendations, the means for each social space’s light levels were calculated. Refer to Table 2 for the light level means for the six areas of the studied CCRC.

The researchers compared the measured light levels and their means to the general lighting recommendations and the specific lighting recommendations for older adults produced by the Illuminating Engineering Society and noted

compliance or non-compliance.



**Figure 1.** Temporary grid marks placed in the Hallway for light meter readings.



**Figure 2.** Researcher records light meter readings on the floor of the Lobby.

## 3. Findings

All six spaces (Lobby, Hallway, Dining Room, Activity Room, Chapel, and Natatorium) were illuminated with electric light. Additionally, with the exception of the Hallway, where there were no windows, all five of the other spaces were also illuminated by daylight. The existing window coverings remained open during the study period. The windows of the CCRC allowed daylight contributions into the Lobby, Dining Room, Activity Room, Chapel, and the Natatorium.

### 3.1. General Population Recommendations

The Illuminating Engineering Society (IES) offered general

illuminance recommendations [18] as shown in Table 1 that are somewhat open to interpretation. The recommendations required users to make determinations as to the visual tasks anticipated in particular spaces. Users of the IES 2000 recommendations are asked to classify anticipated visual tasks such as “public spaces”, “simple orientation for short visit”, “working spaces where simple visual tasks are performed”, and “performance of visual tasks of high contrast and large size” ... (p. 10-13), etc. Then, the associated light levels for the target users were selected. Visual task identification is open to some interpretation on the part of the user, however. The IES also advised that the light level recommendations were considerably higher for the “older adults” than for the recommended range which is intended for the “general population”.

### 3.2. Lobbies

In a CCRC, the lobby is the main social space and it is important to have various light levels which should correspond to and support the variety of activities which may happen there, i.e. waiting, watching for friends or family to arrive, reading, writing, and possibly other visual tasks (IES, 2007) (i.e. needlework). The purpose of task lighting is to illuminate a relatively small area for specific tasks. Selected task lighting must allow flexible positioning to protect users from direct glare. In addition to task lighting, ambient light levels in a lobby should be adjustable for older adults to adapt the light to their various activities [1]. The general IES recommendations include a description of activities. Lighting designers must select target light levels from the list of anticipated activities for a space. Since lobbies may include a variety of visual tasks, one interpretation of the IES 2000 recommendations is that 10-50 footcandles (197.5 – 538.2 lux) are recommended for “working spaces where simple visual tasks are performed” (p. 10-13) to the “performance of visual tasks of high contrast and large size” (p. 10 - 13) in lobbies.

### 3.3. Hallways

The primary function of hallways and other circulation spaces is to make allow traffic to pass safely. While some other rooms use task lighting to meet the needs for more specific work tasks, hallways need to provide a constant level of light [6]. Thus, inadequate lighting in a hallway may contribute to collisions [5]. The illumination of circulation spaces can also aid older adults in adapting to varying lighting levels between activity areas linked by the circulation areas. Adequate light levels in hallways may also contribute to residents’ security [11]. One interpretation of the IES 2000 recommendations is that hallways will need lighting for “simple orientation for short visit” (p. 10-13) and therefore hallways should be illuminated to 5-30 footcandles

(53.8 -322.9 lux).

### 3.4. Dining Rooms

In dining rooms, good lighting helps older adult residents to clearly see the food on the table and also each other’s faces. Dining rooms may also be used as places for visual tasks, such as writing checks or reading mail [11]. One interpretation of the IES 2000 recommendations of the Illuminating Engineering Society (2007) is that dining rooms are “working spaces where simple visual tasks are performed” (p. 10-13) and that dining rooms therefore should be illuminated to 50 footcandles (538.2 lux).

### 3.5. Activity Rooms

Activity Rooms are the spaces in which participants perform leisure tasks, such as playing cards. Appropriate lighting should be supplied to support the specific requirements of various activities [11]. One interpretation of the IES 2000 recommendations is that activity rooms will require the “performance of visual tasks of high contrast and large size” (p. 10-13) and should therefore be illuminated to 30-50 footcandles (322.9 - 538.2 lux).

### 3.6. Chapel

Depending on the institutional affiliation of a CCRC, a chapel may be an integral to the mission of the CCRC. It is important to create a proper atmosphere for worship in a CCRC’s chapel. One interpretation of the IES 2000 recommendations is that chapels are spaces where one would anticipate the “performance of visual tasks of high contrast and large size” (p. 10-13) which therefore would require 30-50 footcandles (322.9 - 538.2 lux). These tasks might include entering the chapel, viewing the celebrant, or recognizing faces in the congregation. Ideally, overhead, general lighting should be provided and shadows should be avoided [19]. Reading religious books and song books are tasks that are also anticipated. In general, a level of 50 footcandles (538.2 lux) is recommended for reading (Illuminating Engineering Society, 2007).

### 3.7. Natatoriums

The selection of appropriate luminaires is critical to ensure proper light levels in a CCRC’s natatorium, as well as to control glare for its older adult occupants. Interior lighting should be installed around the perimeter of the swimming pool [8]. For an indoor swimming pool, a natatorium, proper and even light levels at sufficient levels will provide for safety [1]. One interpretation of the IES 2000 recommendations is that natatoriums are “working spaces where simple visual tasks are performed” (p. 10 - 13) and therefore should be illuminated to 30 footcandles (322.9 lux).

### 3.8. Specific Recommendations for Older Adults

IES offers also some specific illuminance recommendations (2007) for “older adults” for particular tasks or room types. These are shown in Table 2.

Table 2. Illuminance Levels for Older Adults.

|  | Lobby |       | Hallway    |              | Dining room |        | Activity room |       | Chapel |       | Natatorium |        |
|--|-------|-------|------------|--------------|-------------|--------|---------------|-------|--------|-------|------------|--------|
|  | fc    | lux   | fc         | lux          | fc          | lux    | fc            | lux   | fc     | lux   | fc         | lux    |
| Means of light level readings measured in CCRC | 12.0  | 128.6 | 18.6       | 200.2        | 8.00        | 86.1   | 18.0          | 193.8 | 82.3   | 885.9 | 446.9      | 4810.2 |
| Recommended *                                  | 30.0* | 322.9 | 10.0-30.0* | 107.64-322.9 | 50.0        | 538.2* | 30.0*         | 322.9 | 30.0*  | 322.9 | 30.0**     | 322.9  |

\* [11]

\*\* [18]

## 4. Results

The study examined lighting levels in six areas: 1) Lobby, 2) Hallway, 3) Dining Room, 4) Activity Room, 5) Chapel, and 6) Natatorium. Some or all of the light levels that were measured within four (67%) of the examined CCRC’s social spaces: Lobby, Hallway, Dining Room and Activity Room, were found to be *lower* than the specific industry lighting recommendations for the tasks expected to be performed in these areas when one considers the specific standards for “older adults”. Refer to Table 2 for the means of the measured light levels in the CCRC as compared to the specific minimum industry standards for older adults.

In the Lobby, the researchers measured 4 – 20 footcandles (43.1 – 215.3 lux). The mean interior light level was determined to be 12.0 footcandles (128.6 lux). Refer to Table 3 for means of light levels taken in the CCRC. For lobbies, the IES 2007 recommendation for “older adults” is 30 footcandles (322.9 lux). All of the illuminance measurements, as well as the mean for the Lobby, were found to be below the recommended level.

In the Hallway, the measured illuminance levels ranged from 10.0 fc to 43.0 fc (107.6 – 462.9 lux). The mean interior light level was determined to be 18.6 footcandles (200.2 lux). For hallways, the IES 2007 light level recommendation for older adults is 30 fc (minimum) (322.92 lux) during “active hours” (and 10 fc during “sleeping hours”). Note that in the current study, the light levels were measured during “active hours” so the higher recommended light level was utilized. Some of the illuminance measurements as well as the mean for the Hallway were found to be below the recommended level.

In the Dining Room, the measured illuminance levels ranged from 2.0 fc to 14.0 fc (21.5 - 150.7 lux) with a calculated mean of 8 fc (86.1 lux). For dining rooms, the IES 2007 light level recommendation for older adults is 50 footcandles (538.2 lux). Some of the illuminance measurements as well

as the mean for the Dining Room were found to be below the recommended level.

In the Activity Room, where visual attention to detail is important, the measured illuminance levels ranged from 10 - 27 footcandles (107.6 – 290.6 lux) with a mean of 18 footcandles (193.8 lux). The IES 2007 recommended minimum light level for the older adults’ visual tasks anticipated in an activity room is 30 fc (322.9 lux). All of the illuminance measurements, as well as the mean for the Activity Room, were found to be below the recommended level.

In this field study, some of the light levels measured within two (33%) of the examined CCRC’s social spaces, Chapel and Natatorium, were found to be *higher* than the industry lighting recommendations for the tasks expected to be performed by older adults in these areas.

In the Chapel, the measured illuminance levels ranged from 19 to 400 fc (204.5 – 4305.6 lux) and the mean light level was found to be 82.3 footcandles (885.9 lux). The IES 2007 recommendation for older adults’ chapel is 30 footcandles (322.9 lux). The measured illuminance levels in the Chapel were found to have considerable variance. Some of the illuminance measurements for the Chapel were found to be lower than the recommendation and many of the illuminance measurements, as well as the mean of the Chapel, were found to be above the recommended level.

On the indoor Natatorium deck, the measured light levels ranged from 380 to 850 footcandles (4090.3 – 8072.9 lux) with a mean light level of 446.88 footcandles (4810.2 lux). The IES 2007 recommendations for a natatorium deck is 30 footcandles (322.9 lux) for the general population, however, no specific recommendation for “older adults” for a natatorium were found. All of the illuminance measurements, as well as the mean for the Natatorium, were found to be above the recommended level for the general population.

In aggregate, the illuminance measured in the six social

interior spaces in the CCRC during the study period ranged from a low of 8.0 fc to a high of 446.9 footcandles (86.1 – 4810.2 lux). A resident in the CCRC would be exposed to most of these various light levels during the course of daily living.

## 5. Limitations

This is a case study and considers just one CCRC site. Further, this research study considered daylight as well as electric light contributions. The study was performed during a one day period and did not consider seasonal variations or weather variations over time. The study did not utilize nighttime light level comparisons. Finally, researchers considered the social spaces but did not examine residents' living quarters or staff support spaces.

## 6. Conclusions

CCRCs are committed to providing continuing care, housing, and activities that are suited to older adults' health. Because of the special visual needs of a CCRC's residents, it is especially important to provide appropriate interior lighting in social spaces which meets the recommended illuminance levels. Interior lighting in social spaces in CCRCs should be designed to support older adult residents in performing a range of visual tasks.

Based on comparison to industry standards, some existing lighting levels measured in the studied CCRC's social spaces did not meet industry illuminance recommendations. However, the recommendations are open to some interpretation. The studied facility is over 20 years old and could benefit from a lighting renovation. The non-uniform illumination found at the CCRC's facilities create potentially problematic areas of high light level contrasts with glare and deep shadows in evidence. Some of the under-illuminated areas could benefit from supplemental lighting or higher lumen outputs. Some of the uneven lighting in the CCRC appears to be due to daylighting contributions. The daylight produced very high levels of light in the interior, especially nearer to the windows. One option to assist in meeting current industry recommendations would include the utilization of new window treatments which could filter light while the window treatments are closed, to make the overall interior lighting levels more even in the social spaces.

As the number of older adults increase, CCRC facilities are becoming more common. This study is relevant because more in situ case studies are needed to increase the scholarly literature regarding illumination levels for CCRCs. This study demonstrates that in one facility, many of the existing light levels measured did not meet the recommendations for

older adults. Less-than-recommended levels could result in slips and falls, injuries, and lawsuits. It is anticipated that supplementing future light level case studies with studies of older adults' perceptions of their CCRC environments' illumination will be helpful. The resulting lessons learned from this study could prove useful to authors of new lighting recommendations, designers of new facilities, and ultimately benefit older adults and their quality of life.

## Definitions

The following quantitative terms are used in this study [7]:

1. Illuminance: "The density of luminous flux on a surface. The units are the lux and footcandle"
2. Lux: "(lx) the SI unit of illuminance: the illumination on a surface of one meter square on which there is a uniformly distributed flux of one lumen"
3. Footcandle: "(fc) a unit of illuminance: the illumination on the surface one foot square on which there is a uniformly distributed flux of one lumen..."

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