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## *The role of lighting in senior care facility design*

### *Introduction*

Allowedly, the population of most countries in the world is aging. This phenomenon generates problems that will be exacerbated in the future and already require special attention. Aging can be accompanied by various types of pathologies affecting the quality of life for several reasons. Seniors may experience uncertainty or frustration in relation to daily activities, which can prove difficult to perform. Visual and perceptual disorders and their associated symptoms play a significant role in the occurrence of these inconveniences. Cognitive abnormalities lead to spatial and temporal disorientation, disruption of a circadian cycle, thus reinforcing feelings of anxiety, discomfort, and loss of autonomy. Diseases of old age, dementia, depression, and visual impairments such as glaucoma, cataracts, macular degeneration, and others lead to worsened accommodation, visual acuity, and contrast perception, causing deficits in the visual field. Consequently, the perception of the environment by the elderly is disturbed. Conditions like disorientation, failure to recognize spaces, or the inability to identify obstacles increase the risk of falls, disabilities, or fear of impaired mobility and not being able to perform activities as before [1]–[3]. However, it is possible to prevent or eliminate such situations by modifying the environment and adapting it to potential consequences of visual impairments, taking into account the lifestyle and habits of seniors.

The authors of the studies presented in the references demonstrate the importance of lighting in this regard. The results obtained by them show that proper lighting

quality can improve the visual efficiency of the elderly and provide them with both physical and psychological safety and comfort. By combining the quality and quantity of light, contrast levels, and colour temperature of the illumination, tailored to the needs and health of seniors, it is possible to achieve lighting design that meets their expectations [1], [4], [5].

The design of ergonomic lighting for environments intended for the elderly should be based on current and reliable scientific research findings. To achieve this, it is necessary to examine the health issues related to aging eyesight and to identify the latest technological advancements in the field of lighting solutions. Precise design guidelines are also needed to streamline the process of shaping lighting in spaces intended for the elderly population.

### *Material and method*

Bearing in mind the complexity of the issue concerning the aging process of the eyes, changing demographic data regarding the elderly population, and the limited number of studies providing mature and reliable conclusions on the impact of lighting on the visual abilities and motor skills of seniors, it is desirable and promising to conduct multidisciplinary research to enhance knowledge in this field [6]. The primary research method employed by the authors was a literature review. Querying and reviewing the subject literature allowed for the collection and analysis of relevant information in the investigated area. The actions undertaken by the authors included:

- recognition and analysis of perceptual problems in elderly individuals resulting from the aging process of the visual system,
- analysis of the impact of lighting quality on the health, safety, comfort, and satisfaction of seniors,
- discussion of design strategies based on lighting research for older people, aimed at three effects: maintaining

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emotional balance, ensuring efficiency and proficiency in daily activities, and preventing falls.

Another applied research method involved conducting lighting simulations in selected spaces within a senior care facility. These simulations served as the basis for analysing, comparing, and evaluating various lighting solutions, as well as for developing conclusions and guidelines for multi-directional lighting strategies based on visualized design issues and possibilities. The final recommendations regarding lighting parameters, defining them as ergonomic and most optimal for seniors, were supported by research findings published in numerous scientific publications across various disciplines and fields [1]–[8].

### ***Justification of the importance of the issue of lighting in the context of the needs of the elderly***

In the context of an aging population, it is essential to consider the needs of the elderly in architectural and interior design. Lighting is an area of particular significance in designing spaces for seniors – good lighting can contribute to improving the quality of life for the elderly through:

- a positive impact on their well-being,
- facilitating the activities of the elderly,
- ensuring health and safety, e.g., with adequate lighting seniors can avoid falls [4].

The key to achieving these objectives is the awareness and knowledge of designers regarding both the health issues associated with aging vision and the development of the latest technological advancements in lighting solutions. It is important to mention that lighting technologies that have evolved in recent years offer extensive possibilities for improving the quality of spatial usage. However, the majority of spaces specifically designed for the elderly remain under-illuminated. Additionally, they often perceive the lighting in their environment as “sufficiently adequate”. The improper assessment of lighting by seniors can be attributed to the fact that age-related vision loss generally occurs gradually. Older adults are often unaware of changes in their perception, which leads them to retain their habits and lighting solutions. Studies indicate several reasons why architects and interior designers inadvertently incorporate inappropriate lighting in spaces designed for the aging population. Designers typically determine lighting conditions based on the needs of “young eyes”, stemming from a lack of familiarity with the additional requirements of „elderly eyes”. The selection of appropriate lighting solutions to enhance the quality of facilities for seniors should be based on collaboration between designers and scientists [4].

### ***Recognition and analysis of perceptual issues in the elderly resulting from the aging process of the visual system***

Architects and interior designers should understand the limitations of the elderly and those with visual and perceptual impairments. This knowledge is essential for creating an environment that can support functional independence

for an extended period. Academic design education programs provide limited information about the special needs of seniors and those with cognitive impairments, despite the crucial importance of raising awareness and education in this regard [7].

One in six adults aged forty-five and older suffer from some type of vision problem and the risk of vision loss increases with age [7]. Visual impairment, defined as vision loss that cannot be fully corrected with glasses or contact lenses, intensifies with age, potentially leading to unnecessary limitations in independence and reduced quality of life for many seniors. The most common age-related causes of vision loss are macular degeneration, glaucoma, cataracts, and diabetic retinopathy. Changes in the visual system affect visual capabilities, and age-related eye diseases can lead to further impairments, such as difficulty adapting to changes in brightness, increased sensitivity to glare, and reduced contrast sensitivity. Decline in both visual acuity and visual function is one of the most common and potentially disabling conditions in late life, significantly impacting the quality of life for the elderly. Visual impairment and other sensory disturbances also increase susceptibility to hazards. Age-related changes in the eye, associated with loss of visual acuity, hinder the performance of tasks, especially those requiring focus and concentration. They cause difficulties in driving at night and challenges in reading or performing precision work under dim lighting conditions. Visual problems interfere with everyday activities, such as bathing, dressing, meal preparation, or even moving around. They also hinder participation in social and recreational activities, significantly impacting emotional well-being and social relationships, and potentially leading to isolation and depression [2], [3], [7].

Visual capabilities can be significantly increased through improvements in the living environment and certain types of vision loss can be prevented or minimized by adopting a lifestyle changes. The challenge lies in adapting the environment to help compensate for visual changes. Higher quality and quantity of appropriate lighting can assist in minimizing the effects of normal age-related vision changes and maximize the abilities of the elderly [7].

### ***Analysis of the impact of lighting quality on the health, safety, comfort, and satisfaction of the elderly***

The concept of good lighting is evolving along with the latest research findings in neurobiology, chronobiology, and studies on vision and lighting. The science of chronobiology elucidates the gift of daylight, investigating mechanisms through which light influences humans sleep, digestion, and immune responses. Chronobiology also uncovers how biological rhythms can be harnessed for health benefits. Considering and controlling the fundamental properties of light for the circadian cycle, as well as for the visual system, by scientists and designers, can contribute to advancements in providing “healthy” lighting, which supports human health [7]. In designing spaces for the elderly architects make decisions that impact the health, safety, activity, and well-being of seniors.

Lighting is considered an integral element in achieving the goal of a healthy living and activity environment for them. For individuals, such as the elderly, who spend most of their time indoors, a lack of light can have far-reaching consequences. The benefits of lighting extend beyond mere visibility and creating a pleasant atmosphere in the space. Based on research, four effects resulting from the implementation of ergonomic lighting can be observed:

- visual: enabling vision, perception of the environment, and coping with cognitive tasks,
- emotional: the mutual interaction of light and colour triggering moods and emotions; particularly important in interior design,
- biological: light uniquely affects the human circadian cycle and influences health and well-being,
- energy efficient: light should be supplemented where necessary, e.g., in the absence of sufficient natural light in the room [8].

Light received by the eyes serves for vision and regulation of human body functions – influencing neurological and metabolic processes. It has a significant impact on the production of melatonin, cortisol, and serotonin, the three most important hormones controlling the biological rhythm:

- melatonin induces fatigue, slows down bodily functions, and reduces activity in favour of well-deserved rest,
- cortisol is the stress hormone produced from around 3 am, stimulating metabolism and programming the body for the daytime mode,
- serotonin: acts as a stimulant and motivator – while cortisol levels decrease during the day, in a “counter-cyclical” manner to melatonin levels, serotonin helps increase energy levels – in a 24/7 cycle [8].

Altered sleep and activity patterns, as well as the production or suppression of hormones, are only a part of a larger desynchronization of various rhythms in the elderly, caused by changes in the aging body. Many seniors are more susceptible to sleep disorders, depression, and weakened immune systems. Light proves to be a potent regulator. Biologically effective ambient light can be the main stimulus regulating their circadian cycle. By attempting to mimic the action of natural light to balance the human circadian cycle, a biodynamic lighting system should have parameters similar to those found in nature. Clinical studies have confirmed the effectiveness of light therapy in treating winter depression and selected circadian dysfunctions, including sleep disorders in the elderly, even those with dementia and Alzheimer’s disease [5]–[9].

Research findings reveal several important relationships between lighting and the functioning and performance of the elderly:

- regulated LED lamps are beneficial not only for the safe navigation of the elderly but also for maintaining their circadian cycle,
- aging eyes poorly adapt to very bright or dim lighting; hence, appropriate lighting levels are necessary,
- poor lighting conditions can contribute to falls in the elderly,
- visual cues providing a nighttime pathway from the bed to the bathroom can enhance stability and prevent falls, thus ensuring safety,

- increased exposure to daylight can also positively impact the sleep quality of the elderly at night,

- with the development of tunable LED lamps, it is expected that innovative solutions will facilitate safe navigation for the elderly at night and improve their circadian cycle [6].

Light is a design tool that has a tremendous impact on many aspects of human behaviour and health. Visual performance, atmosphere, safety and protection all depend on lighting. Adequate lighting is the foundation of a supportive environment that enhances the capabilities of the elderly, promotes their well-being, and helps prevent accidents. Weak or improper lighting reduces their independence, jeopardizes their health and safety, and diminishes their quality of life. As such, design innovations in lighting technology must not only support vision but also consider the photo-biological effects of light on the body and human circadian cycle [7], [9].

### *Strategies in lighting design for the elderly*

The approach to designing and using lighting focused on the healthcare of seniors should consider the perceptual issues in the elderly resulting from the aging process of the visual system. Undesirable conditions, such as under-illumination in interior spaces, can occur due to lack of sunlight resulting from the time of day and year, weather conditions, inadequate window openings, or improper positioning of artificial lighting sources in spaces dominated by artificial light. The level of lighting intensity should be appropriately adjusted to the activities performed and the individual needs of the elderly. Well-lit areas for visual tasks, such as kitchen countertops, reading corners, workstations, personal care areas, encourage engagement and activity. Effective lighting in corridors and passageways aids safe mobility. Due to anatomical and physiological changes in the visual system of the elderly compared to young individuals, higher levels of lighting intensity are required. In comparison to a twenty-year-old’s eye, only one-third of the light reaches the interior of an older individual’s eye due to a smaller pupil diameter and lens opacity, which should be considered when selecting appropriate lighting [10].

Strategic, healthcare-focused approaches to planning, installing, and using lighting in the living environment of seniors are based on three effects that can be achieved through light concerning the psycho-physical functioning of humans:

- emotional balance,
- efficiency,
- fall prevention [4].

#### *Emotional balance*

Elderly requiring long-term care often have limited access to natural daylight and the biological and emotional balance it provides. By regulating the brightness and colour temperature of lighting, a positive impact can be made on the mood of the elderly. Advanced lighting technologies allow designers to create a dynamic artificial lighting system that mimics the properties of natural daylight [4].

The concept of Tunable White biodynamic lighting emerged from research on the impact of lighting on the

human body, well-being, and daily functioning. It mimics daylight and its changing colour temperature throughout the day. Utilizing the capabilities of tunable lighting technology in terms of colour temperature positively influences the body's circadian cycle and melatonin production. By adjusting the colour temperature of light, it is possible to emulate daylight: in the morning, a higher concentration of blue light with a cool white colour temperature of 4700 K can provide stimulating properties, increasing alertness and concentration while suppressing melatonin production. In the evening, warmer light with a colour temperature of 2400 K and reduced blue content emulates sunset light, providing relaxing and calming properties [11], [12].

A study was conducted at a senior care facility in Sacramento, California, to investigate how tunable lighting affects sleep patterns, nighttime safety, and lighting quality for staff. Research results related to elderly care suggest that cool colour temperatures and brightness can help prevent falls and improve visual acuity, while warmer colour temperatures can enhance sleep and reduce agitation and anxiety during late hours for patients with Alzheimer's or dementia [13], [14].

The benefits of implementing the Tunable White Concept:

- regulation of the circadian cycle,
- improved sleep quality and rest,
- enhanced productivity and efficiency throughout the day,
- ensuring safety during nighttime bathroom use,
- improved visual acuity,
- prevention of glare [15].

Brightness and colour temperature of lighting can become supporting tools for emotional balance in the elderly, counteracting stress and anxieties by increasing comfort and satisfaction with the environment and reinforcing positive moods. To achieve this, it is important to consider certain guidelines:

- for the elderly, a well-lit interior is perceived as warmer and more friendly and comfortable,
- seniors are more satisfied when their surroundings have a well-arranged lighting scheme that utilizes various light sources – general ceiling lighting, wall lighting, and accent or decorative lighting,
- light on multiple surfaces reduces shadows which can help older people feel more comfortable and physically stable while moving around in the space,
- the brightness and colour temperature of light shape the emotional quality of lighting in senior care facilities – e.g., they can prevent negative emotions related to experiencing stress in a new territory, a new community, or anxiety about medical care [4].

### *Efficiency*

Weak lighting has a negative impact on the concentration of the elderly and causes difficulties in performing daily activities such as:

- determining their own location,
- reading labels and information,
- fulfilling personal needs.

Certain design guidelines can be formulated to create conditions that facilitate navigation for older people, enable reading of information from a distance, enhance detail perception, and improve clarity and visual comfort. These include:

- providing low glare (non-glare) lighting,
- offering indirect lighting (reflected lighting),
- choosing a higher colour temperature of light (e.g., 4100 K – cool white),
- ensuring higher colour rendering index (if  $R_a$  is above 85, objects appear more natural)
- avoiding strong contrasts between surface finishes (e.g., bright wall contrasting with the floor),
- selecting surfaces with low reflectance, reducing glare,
- introducing high-contrast signage, where letters, signs, and all information are easily distinguishable [4], [6].

### *Fall prevention*

Limited lighting hinders seniors' ability to move safely in their surroundings, both indoors and outdoors. When the light level is low, older people experience greater difficulties in mobility and balance, leading to unnecessary stops, which pose a threat to their health and safety. Problems with mobility, such as bumping into objects, groping with hands or feet, interrupting normal gait, requiring constant contact with surrounding objects, needing observer intervention, and losing reference point, increase by 121% when the light level in the room is too low. The same mobility issues at night increase by 291% when the outdoor light level is too low [4].

Appropriately increasing the amount of light in areas with the highest likelihood of falls can impact the safety of seniors, but lighting systems are recommended to be placed in certain zones because:

- visual cues in low-lit surroundings assist seniors in mobility,
- subtle night lighting illuminating walking paths, which do not disrupt sleep like overhead lights, can potentially reduce the risk of falls in the elderly,
- lighting around door frames helps reduce the transition time from a sitting to standing position<sup>1</sup> [2], [4], [6], [16], [17].

<sup>1</sup> Elderly people are very likely to fall during the night. The risk of falling is also increased when seniors change positions, e.g., when they rise from a sitting to standing position. Research confirms that low illumination around the door frame is the most helpful feature in reducing the transition time from sitting to standing. There are several reasons why subtle illumination of the door frame is more effective than high levels of ambient lighting. The luminous door frame provides visual cues, using lighting to reduce the risk of falling for the elderly without disrupting their sleep by turning on a bright overhead light. This solution provides low-intensity ambient lighting with improved horizontal information when walking. They can complement conventional night lamps and light lines marking paths, as perceptual clues about the horizontal plane of walking, also affecting the maintenance of balance [16], [17]. Door lighting can also have a psychological effect, motivating the elderly. It can encourage seniors to get out of bed quickly, take a standing position, be brave and ready to "go outside, to other people" in order to take up activity, despite various ailments and obstacles.

### ***Development of design guidelines for multi-directional strategies of lighting***

Practical applications of the previously discussed issues affecting the comfort and efficiency of older people in care facilities can be identified. The considerations were carried out on the example of two spaces where seniors spend relatively the most time – on the example of the patient room and the general communication zone (Fig. 1).

#### *Biodynamic lighting*

The right amount and quality of lighting helps in the daily synchronization of our internal clock. Due to insufficient light or the negative impact of constant lighting, problems with maintaining the circadian cycle, sleep disorders or depression may occur. Seniors in nursing homes are particularly vulnerable to these inconveniences. Appropriate biodynamic lighting systems, by imitating the day cycle and changing the brightness and colour temperature of light, have a positive effect on the functioning of the elderly as well as the effectiveness of their activities. Special lighting control systems manage changes in colour temperature from cool white with the addition of blue in the morning (Fig. 2a, colour temperature of light: 5500 K, light intensity: 200–300 lux), through white at noon (Fig. 2b, colour temperature of light: 5000 K, light intensity: 200–300 lx), up to warm white with a red-orange tint of lighting in the evening (Fig. 2c, colour temperature of light: 3500 K, light intensity: 200–300 lx). This solution has a positive effect on the hormonal balance of the elderly [8], [11], [12].



Fig. 1. The baseline state for the conducted research: a) patient room, b) general communication zone (elaborated by S. Chrzanowski)

II. 1. Stan wyjściowy dla przeprowadzonych badań: a) sala pacjentów, b) komunikacja ogólna (oprac. S. Chrzanowski)



Fig. 2. Scheme of biodynamic lighting imitating the circadian cycle: a) morning lighting, b) noon lighting, c) evening lighting (elaborated by S. Chrzanowski)

II. 2. Schemat oświetlenia biodynamicznego naśladowującego cykl dobowy: a) oświetlenie poranne, b) oświetlenie dzienne, c) oświetlenie wieczorne (oprac. S. Chrzanowski)



Fig. 3. Comparison of lighting quality on the example of luminaires used in the communication zone:  
a) direct lighting, b) indirect lighting (elaborated by S. Chrzanowski)

II. 3. Porównanie jakości oświetlenia na przykładzie opraw oświetleniowych zastosowanych w strefie komunikacyjnej:  
a) oświetlenie bezpośrednie, b) oświetlenie pośrednie (oprac. S. Chrzanowski)

#### *Types of luminaires (direct/indirect lighting)*

The type of luminaire and the direction of light are of great importance for the physical and mental comfort of seniors. Direct lighting, when the light beam is directed down towards the floor, has definitely less advantages than indirect lighting, when the light is reflected from the surface of the ceiling (a hybrid solution combining both methods is also beneficial). The exposure to direct light causes great discomfort in the elderly (Fig. 3a, light colour temperature: 5000 K, light intensity: 400–500 lx). In addition, overhead lighting creates dark and harsh shadows on faces, interfering with non-verbal communication. Indirect lighting significantly minimizes glare (Fig. 3b, light colour temperature: 5000 K, light intensity: 200–300 lx). This is of particular importance in the patient room, especially in the case of bedridden patients. Indirect lighting also makes spaces appear brighter and larger (Fig. 3b) [2], [3].

#### *Lighting balance (bright/dark lighting)*

For adequate physical and mental comfort, uniformity of lighting is also necessary. Contrasting transitions of light and dark spaces cause eye strain and discomfort in older people (Fig. 4a, light colour temperature: 5000 K, average light intensity: 100–150 lx, irregular lighting). In addition, dark spaces in a new environment (nursing home) in which seniors have to adapt, can lead to fears and anxieties (Fig. 4a). It is recommended that the lighting in rooms, especially elongated ones, should be uniform throughout their space (Fig. 4b, light colour temperature: 5000 K, average light intensity: 200–300 lx, uniform lighting) [2], [3].

#### *Light and floor finishing material (reflections)*

Floors in facilities such as nursing homes should be matt, non-reflective for several reasons. First of all, floor materials with a high-gloss finish can cause glare – visual sensation with discomfort and loss of ability to recognize objects and shapes (Fig. 5a, light colour temperature: 5000 K, light intensity: 200–300 lx). Strong reflections on the floor may also suggest a wet surface (Fig. 5a). The contrast between the floor and the walls allows for orientation in space and efficient movement. Due to these arguments, matt materials seem to be a much more favourable and safer solution (Fig. 5b, light colour temperature: 5000 K, light intensity: 200–300 lx), [2], [3].

#### *Multifunctional lighting in patient rooms*

Many luminaire manufacturers offer multifunctional solutions for patient rooms. Creating several different lighting scenarios for specific activities is possible thanks to only one device. The lighting in the patient room should create a friendly and safe environment – bright enough, and at the same time warm and glare-free.

General lighting should interact with daylight to ensure the right amount of light in the room (Fig. 6a, light colour temperature: 3500 K, light intensity: 100–500 lx close to floor). The diffusion of direct and indirect light provides the right conditions to clearly perceive objects near and far without eye strain. In addition, adjusting the brightness and colour temperature of the light is an effective solution. Intense cooler light can accompany activities during the day, and subtle warmer light can create a pleasant and cosy mood to rest in the evening [2], [3].



Fig. 4. Comparison of lighting quality on the example of luminaires used in the communication zone:  
a) irregular lighting, b) uniform lighting (elaborated by S. Chrzanowski)

II. 4. Porównanie jakości oświetlenia na przykładzie opraw oświetleniowych zastosowanych w strefie komunikacyjnej:  
a) oświetlenie nieregularne, b) oświetlenie równomierne (oprac. S. Chrzanowski)



Fig. 5. Comparison of lighting performance in the context of finishing materials used on the floor in the communication zone:  
a) glossy floor finish, b) matt floor finish (elaborated by S. Chrzanowski)

II. 5. Porównanie działania oświetlenia w kontekście materiałów wykończeniowych zastosowanych na posadzce w strefie komunikacyjnej:  
a) błyszczące wykończenie posadzki, b) matowe wykończenie posadzki (oprac. S. Chrzanowski)

The patient room is also a workplace for medical staff. Adequate lighting during daily activities or examinations is necessary for their proper performance (Fig. 6b, colour temperature of light: 3500 K, light intensity: 300–500 lx at the level of patient bed). There are situations when patients and staff are in their own shadows, so it is important to use glare-free light with sufficient brightness directed

at the patient. This solution greatly facilitates the work of carers or medical staff and makes care more effective.

The correct combination of glare-free lighting and a precise night lamp creates comfortable reading conditions (Fig. 7a, light colour temperature: 3500 K, light intensity: 300–500 lx at the level of patient's bed). In addition, due to the direct contact of the patient with the



Fig. 6. Examples of using a multifunctional adjustable luminaire in a patient room:  
a) general lighting, b) examination lighting (elaborated by S. Chrzanowski)

Il. 6. Przykłady zastosowania oprawy wielofunkcyjnej regulowanej w sali dla pacjentów:  
a) oświetlenie ogólne, b) oświetlenie do badań (oprac. S. Chrzanowski)

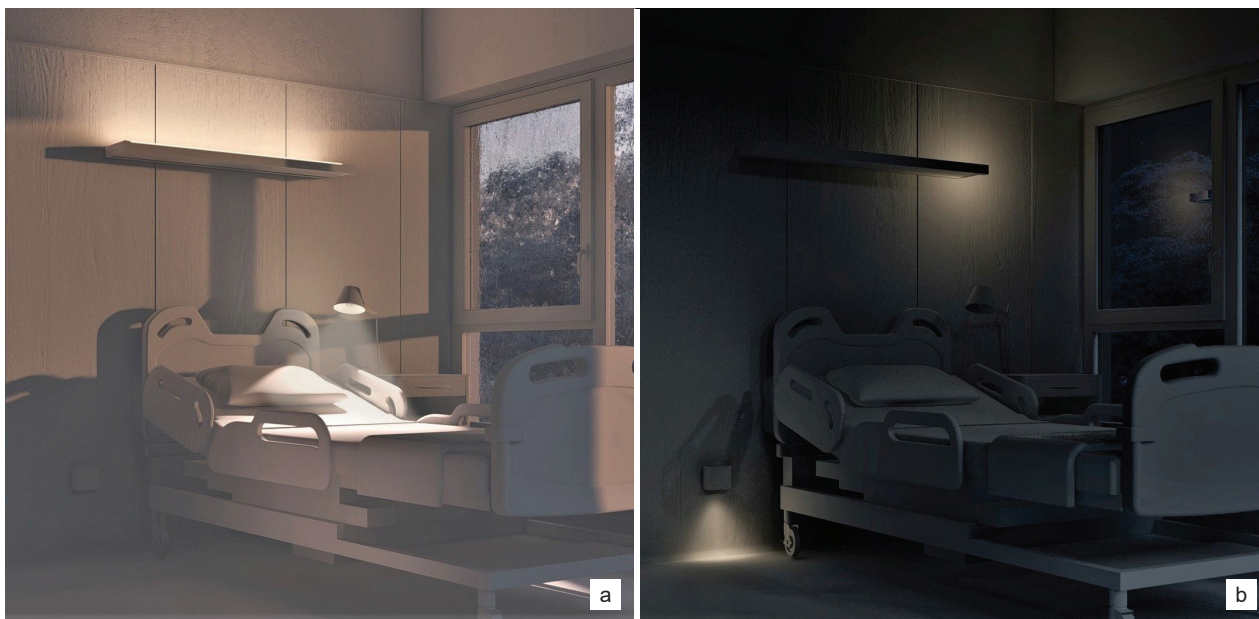


Fig. 7. Examples of using a multifunctional adjustable luminaire in a patient room:  
a) reading lighting, b) night lighting (elaborated by S. Chrzanowski)

Il. 7. Przykłady zastosowania oprawy wielofunkcyjnej regulowanej w sali dla pacjentów:  
a) oświetlenie do czytania, b) oświetlenie nocne (oprac. S. Chrzanowski)

luminaire, safety is important – low heat emission, no risk of burns, no glare and ease of use.

Subtle night lighting should guide staff to patients during night check-ups without disruption by the glaring light (Fig. 7b, light colour temperature: 3500 K, light intensity: 50–100 lx close to floor). In addition, the luminaires can create safe pathways for seniors in rooms or corridors [2], [3].

### Conclusions

The design approaches discussed in the article, including lighting for emotional balance, lighting for efficiency and lighting to prevent falls, can help to effectively solve some of the health problems faced by older people. The simulations carried out show the importance of taking into account the features of “good lighting” in the process



of shaping the lighting conditions, e.g., in terms of the type, location, quantity, intensity, level, diffusion or colour temperature of light. Control of lighting effects such as glare, reflections, shadows, strong contrasts, can prevent unfavourable lighting conditions. The application of the biodynamic lighting concept is a beneficial solution to support design strategies focused on senior health care.

The adequate amount and quality of light are the basic components of an effective lighting system, which should also be “energy efficient”, combining the right quality of light with the most efficient lighting system [7], [9].

Ensuring good lighting for the elderly is a complex task that should take into account the ability of seniors to perform normal activities of daily living as well as their cognitive difficulties and limited physical fitness.

Design guidelines to balance changes in the aging eye include:

- increasing the level of lighting due to loss of visual acuity,
- ensuring a constant and uniform, even level of lighting, eliminating unnecessary shadows and optical illusions,
- elimination or reduction of glare, taking into account the greater sensitivity of older eyes,
- ensuring gradual changes in lighting levels, taking into account transition areas between external and internal parts (e.g., entrance halls, vestibules) and between different interiors (e.g., corridors, halls),
- providing access to natural daylight and controlling the quality of light diffusion depending on the exposure,
- balancing natural light and artificial light, e.g., by using various solutions regulating the access of sunlight (shutters, blinds, curtains, etc.),
- increasing the level of lighting in the kitchen and bathroom,
- use of indirect lighting to prevent eye fatigue,
- increasing the light intensity in the task area, ensuring higher contrast,

- taking into account the interaction of light and colour affecting spatial perception when choosing the colour of lighting (day white or warm white),
- increasing the colour rendering index of the light source,
- application of biodynamic lighting technology,
- application of lighting control technology that is easy and intuitive to use by the elderly,
- taking care of the control and maintenance of the lighting installation [2], [3], [6]–[9], [18], [19].

### Summary

Considering the aging population, architects and interior designers should be guided in their activities by the prospective thought of the increasing need for senior care. Technologies that have developed in recent years, including lighting solutions, offer a wide range of opportunities to improve the usable quality of spaces intended for the elderly. The latest solutions make it possible to create a lighting plan taking into account the expectations and requirements of the elderly, which is a complex and multifaceted process. The list of needs is long and varied – from balancing artificial and natural light to ensuring adequate lighting in specific functional zones. Optimal use of innovative lighting technologies and systems based on ergonomic design guidelines can significantly improve lighting conditions for older people. The three strategic design approaches discussed in the article, including lighting for emotional balance, for efficiency and preventing falls, are the steps to a multi-directional lighting concept. The method can be effective in solving health problems of the elderly and improving their everyday living conditions. The issue of designing lighting for seniors requires further, in-depth research, with particular emphasis on innovative energy-efficient systems.

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## Abstract

### *The role of lighting in senior care facility design*

Shaping ergonomic lighting in spaces dedicated to seniors requires reliable knowledge from designers both in terms of health issues related to the aging of the eyesight and innovative lighting solutions. Design guidelines based on credible scientific results are also desirable. To complement the information in this field, the authors identified perceptual problems in the elderly due to the aging process of the visual system and analyzed the impact of lighting quality on the health, safety, comfort, and satisfaction of the elderly. Because eyesight deteriorates with age, older people have to deal with the effects of insufficient or inappropriate lighting. For this reason, there is a need to adapt lighting solutions to the requirements of seniors, taking into account the process of weakening of the visual system. Design strategies focused on three lighting effects were discussed: maintaining emotional balance, ensuring efficiency in everyday activities, and preventing falls. Lighting simulations were also made on selected examples of interiors in the senior care facility. They provided the basis for the analysis, comparison and evaluation of various lighting solutions and the development of conclusions and guidelines for multi-directional lighting strategies based on visualized design problems.

**Key words:** design for the elderly, lighting for the elderly, ergonomic lighting, biodynamic lighting, age-related vision and perception disorders

## Streszczenie

### *Rola oświetlenia w projektowaniu placówek opieki dla osób starszych*

Kształtowanie ergonomicznego oświetlenia w przestrzeniach przeznaczonych dla seniorów wymaga od projektantów rzetelnej wiedzy zarówno w zakresie problematyki zdrowotnej związanej ze starzeniem się wzroku, jak i innowacyjnych rozwiązań oświetleniowych. Pożądane są również wytyczne projektowe oparte na wiarygodnych wynikach badań naukowych. Aby uzupełnić informacje w tej dziedzinie, autorzy rozpoznali problemy percepcyjne osób w podeszłym wieku wynikające z procesu starzenia się układu wzrokowego oraz przeanalizowali jakość oświetlenia w kontekście wpływu na zdrowie, bezpieczeństwo, komfort i satysfakcję osób starszych. Ponieważ wzrok pogarsza się wraz z wiekiem, osoby starsze muszą radzić sobie ze skutkami niedostatecznego lub niewłaściwego oświetlenia. Z tego względu pojawia się potrzeba dostosowania rozwiązań oświetleniowych do wymagań seniorów z uwzględnieniem procesu osłabiania się układu wzrokowego. Omówione zostały strategie projektowe ukierunkowane na trzy efekty, jakie można uzyskać dzięki odpowiedniemu oświetleniu (utrzymanie równowagi emocjonalnej, zapewnienie wydajności i sprawności w codziennych działaniach oraz zapobieganie upadkom). Przeprowadzono również symulacje oświetlenia na wybranych przykładach wnętrz w domu opieki dla seniorów. Dały one podstawę do analizy, porównania i oceny różnych rozwiązań oświetleniowych oraz opracowania wniosków i wytycznych do tworzenia wielokierunkowych strategii oświetleniowych opartych na zwizualizowanych problemach projektowych.

**Słowa kluczowe:** projektowanie dla osób starszych, oświetlenie dla osób starszych, oświetlenie ergonomiczne, oświetlenie biodynamiczne, zaburzenia wzroku i percepcji w podeszłym wieku