# Light conditions in nursing homes : visual comfort and visual functioning of residents

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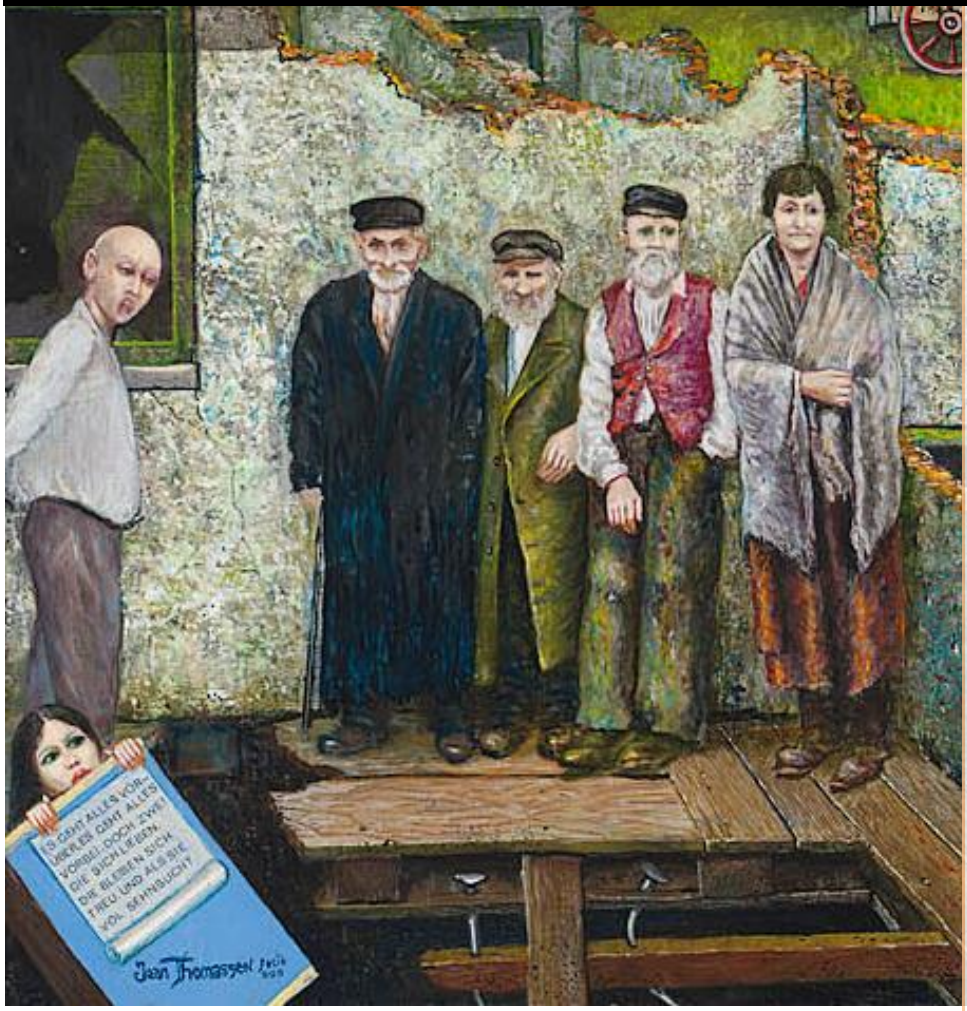

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**Marianne M. Sinoo**

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# Light Conditions in Nursing Homes: Visual Comfort and Visual Functioning of Residents

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# Light Conditions in Nursing Homes: Visual Comfort and Visual Functioning of Residents

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# Light Conditions in Nursing Homes: Visual Comfort and Visual Functioning of Residents

## Summary

The Netherlands is experiencing significant ageing, resulting in a growing number of older adults. Multimorbidity increases with age, even more so when there is increasing frailty such as among nursing home residents. Impaired vision is a relevant chronic disability experienced by frail older adults. Changes in the visual system with age and changes due to eye disease involve reduced visual acuity, sensitivity to light, contrast sensitivity, colour discrimination, and a greater sensitivity to glare. For nursing home residents, it is important to provide sufficient light (>750 lx) in the nursing home living environment (common rooms) without producing discomfort or glare

The main aims of this thesis are to describe the light conditions of the nursing home environment in relation to visual functioning and the quality of eye care.

The International Classification of Functioning (ICF) model is applied as a framework to identify environmental factors that hinder or support the daily life of older adults in nursing homes. The addressed environmental factors are building physical aspects (light conditions) and professional (eye) care as a social aspect.

In the first chapter, the main aims of this thesis are introduced.

In chapter 2, a field study was performed to study the light conditions in nursing homes as a building physical aspect. In seven nursing home buildings, single spot measurements were obtained in common rooms and corridors to describe the light conditions in terms of horizontal and vertical illuminance levels (lx) and correlated colour temperature (K). In the seven nursing home buildings, both vertical illuminance as well as horizontal illuminance in the common rooms fell significantly below the 750 lx reference value in more than 50% of the measurements. This pattern was also found in corridors (reference value 200 lx). Correlated colour temperature, which contributes to a person's biological clock, fell significantly below the reference value for daylight of 5,000 K in all participating nursing home buildings. These nursing home environments might therefore limit the daily activities and social participation of the residents. Hence, care professionals working in nursing homes need to pay attention to the light needed to engage in certain leisure activities, such as eating and reading. The indoor environment (as a building physical aspect) is important, as well as raising awareness among care professionals (as a social aspect) on the visual problems of the residents.

Therefore, in chapter 3, the actual visual status of the nursing home residents, as well as the communication regarding visual functioning in client records, was studied. The results of optometrists' eye examinations of 259 residents were related to the documentation of eye disease/visual problems in the client files. The results revealed that a third of the nursing homes residents had visual problems that required further

examination by an ophthalmologist. In these cases, a significant proportion of client records showed no recorded information. To raise awareness among care professionals, problems with visual functioning need to be assessed and captured in client records. Because of the influence of light on nursing homes residents, these problems in visual functioning should also be related to the quality of light conditions.

In chapter 4, the residents' visual pathologies were related to the quality of light conditions of the nursing home environment. Concerning the building physical aspects, this analysis showed that residents live in rather 'dark' environments. The finding of poor light conditions in nursing homes combined with the high prevalence of visual problems (with cataracts found to be the most common age-related pathology) stresses the importance of enhancing awareness of the need to provide better quality of eye care by professional caregivers. Nursing home physicians play a central role in this.

Therefore, in chapter 5, a digital survey was administered to study the role of Dutch nursing home physicians (NHPs) in the eye care of their residents and the collaboration with eye care-related professionals inside and outside of the nursing home. More than 50% of the Nursing Home Physicians stated that they regularly examine some aspects of visual functioning. However, some NHPs 'almost never' or 'never' examine these aspects. Furthermore, the collaboration with external eye care professionals was considered to be not routine for 50% of the NHPs. Opticians were rarely contacted, and optometrists and orthoptists were 'never' contacted by more than 50% of the NHPs. The survey of nursing home physicians clearly revealed that relevant visual aspects are not routinely examined and recorded in client files. The NHPs' role in providing eye care can be improved by the development of guidelines for standardised vision screening, structural documentation in the client files, and seeking plus undertaking collaboration with other eye care professionals. Furthermore, awareness of the light quality of the nursing home environment in all care professionals can be raised by a discussion tool.

Accordingly, in chapter 6, an Environmental Observation tool for the Visually Impaired (EOVI) was developed and validated. The hypothesis is that the tool will contribute to raise professional's awareness of environmental fit (light conditions and reduced visual functioning). The content validity of this developed discussion tool (Environmental Observation tool for the Visually Impaired) for nursing home staff was determined. The tool targets aspects of the nursing home environment, containing observational items such as 'light', the use of 'colours and contrasts' and 'furnishing and obstacles'. The content validity assessment led to a decrease in the number of items from 63 to 52. The final tool of 52 items contains 21 items for *Corridors*, 17 for the *Common Room*, and 14 for the *Bathroom*.

In conclusion, systematically collected information about the nursing home environment and nursing home staff's awareness of the relationship between the environment and visual functioning is a resource for improving eye care and for discussing and solving indoor environmental-related problems for frail older adults.

# Light Conditions in Nursing Homes:

# Visual Comfort and Visual Functioning of Residents

## Samenvatting

De toenemende vergrijzing in Nederland leidt tot een groeiend aantal ouderen. Multimorbiditeit neemt toe met de leeftijd, vooral als er sprake is van een toenemende kwetsbaarheid, zoals onder verpleeghuisbewoners. Verminderd gezichtsvermogen is een van de relevante chronische beperkingen van kwetsbare ouderen. Bij het stijgen der leeftijd treden verandering op in het visuele systeem, maar ook als gevolg van oogziekten. Deze veranderingen omvatten: verminderde gezichtsscherpte, lichtgevoeligheid, verminderde contrastgevoeligheid, verminderd kleurenzien en een grotere gevoeligheid voor schittering of verblinding. Voor verpleeghuisbewoners is het belangrijk om voldoende licht (> 750lx) te hebben, zonder dat dit tot ongemak of verblinding leidt.

Doel van dit proefschrift is om de lichtomstandigheden in de verpleeghuisomgeving te beschrijven in relatie tot het visueel functioneren van de bewoners en de kwaliteit van de oogzorg.

Uitgangspunt is het ICF model, dat als uitgangspunt dient om omgevingsfactoren te identificeren die belemmerend of ondersteunend kunnen zijn voor het dagelijks leven van ouderen in het verpleeghuis. De onderzochte omgevingsfactoren zijn: licht, als een bouw fysisch aspect en professionele (oog) zorg, als een sociaal aspect.

In het eerste hoofdstuk worden de doelstellingen van dit proefschrift geïntroduceerd.

In hoofdstuk twee wordt een veldonderzoek beschreven waarin de lichtcondities in verpleeghuizen onderzocht worden als bouw fysisch aspect.

In zeven verpleeghuishuisgebouwen worden puntmetingen uitgevoerd in de huiskamers en gangen. De horizontale - ($E_h$), verticale verlichtingssterkte ($E_v$) en kleurtemperatuur (K) werden gemeten. In de zeven verpleeghuisgebouwen was in meer dan 50% van de metingen zowel de verticale - als de horizontale verlichtingssterkte in de huiskamers aanzienlijk lager dan de 750 lx referentiewaarde. Dit patroon werd eveneens in de gangen gevonden (referentiewaarde 200 lx). In alle deelnemende verpleeghuisgebouwen werd een kleurtemperatuur gemeten beneden de referentiewaarde voor daglicht van 5,000 K. Deze verpleeghuisomgevingen zijn beperkend voor dagelijkse activiteiten en sociale participatie van de bewoners. Vandaar dat het van belang is dat zorgprofessionals die werkzaam zijn in verpleeghuizen aandacht besteden aan licht voor bewoners bij het uitvoeren van activiteiten, zoals eten en lezen. Naast het verbeteren van de omgeving in het verpleeghuis (als bouw fysisch aspect) is het eveneens van belang dat zorgverleners (als een sociaal aspect) zich bewust worden van de relatie tussen de omgeving en visuele beperkingen van de bewoners.

Daarom wordt in hoofdstuk drie de daadwerkelijke visuele status van verpleeghuisbewoners, onderzocht, evenals de gegevens omtrent het visueel functioneren die zijn opgetekend in het zorgdossier. De resultaten van het optometrisch oogonderzoek van 259 bewoners werd gerelateerd aan de opgetekende oogaandoeningen/visuele problemen in het betreffende zorgdossier. Uit de resultaten bleek dat een derde van de verpleeghuisbewoners visuele problemen had en hiervoor doorverwezen werd naar een oogarts. In deze gevallen werd van een aanzienlijk aantal geen informatie in het zorgdossier gevonden. Om het bewustzijn onder zorgprofessionals te vergroten moeten problemen met visueel functioneren worden bepaald en vervolgens worden opgeslagen in het zorgdossier. Vanwege de invloed van licht op verpleeghuisbewoners moeten de problemen op het gebied van visueel functioneren ook gerelateerd worden aan de kwaliteit van de lichtomstandigheden.

In hoofdstuk vier werd de gevonden visuele pathologie gerelateerd aan de lichtkwaliteit in het verpleeghuis. Met betrekking tot de bouw fysische aspecten bleek dat de bewoners leven in een 'donkere' omgeving. De vondst van slechte lichtomstandigheden in verpleeghuizen in combinatie met een hoge prevalentie van visuele problemen (cataract als de meest voorkomende leeftijd gerelateerde pathologie), wijst op de noodzaak tot een betere bewustwording van de kwaliteit van de oogzorg door professionele zorgverleners. Verpleeghuisartsen spelen hierin een centrale rol.

Daarom is in hoofdstuk vijf een digitale enquête uitgevoerd om de rol van de Nederlandse verpleeghuisartsen te bestuderen bij het uitvoeren van oogonderzoeken, het optekenen van de resultaten in zorgdossiers en de samenwerking met zorgprofessionals binnen en buiten het verpleeghuis. Meer dan 50% van de Verpleeghuisartsen verklaarde dat zij regelmatig een aantal aspecten van het visueel functioneren onderzochten. Echter, sommige verpleeghuisartsen doen dit ‘bijna nooit’ of ‘nooit’. Verder beschouwt 50% van de verpleeghuisartsen de samenwerking met oogzorgprofessionals als niet structureel. Door meer dan 50% van de verpleeghuisartsen worden opticiens zelden gecontacteerd en optometristen en orthoptisten nooit. Uit de enquête voor verpleeghuisartsen bleek dat relevante visuele aspecten niet structureel worden onderzocht en opgetekend in de zorgdossiers. De rol van de verpleeghuisartsen in het verstrekken van oogzorg kan worden verbeterd door de ontwikkeling van richtlijnen voor screening, verbetering van de opname van resultaten in het zorgdossier en samenwerking met oogzorg professionals. Bovendien is de bewustwording van de verpleeghuisomgeving voor alle zorgprofessionals van belang. Deze bewustwording kan verhoogd worden door het gebruik van een discussie instrument.

Dienovereenkomstig is in hoofdstuk zes een Omgeving Observatie instrument voor mensen met een Visuele Beperking (OOVB) ontwikkeld en gevalideerd. De hypothese is dat het instrument zal bijdragen aan professionele bewustwording om de omgeving aan te passen aan de klachten van de bewoners (aanpassen lichtomstandigheden bij verminderd visueel functioneren). De inhoudsvaliditeit van dit discussie instrument (OOVB) werd bepaald. Het instrument is gericht op aspecten binnen het verpleeghuis, zoals ‘licht’, het gebruik van 'kleur en contrast' en 'inrichting en obstakels'. De inhoudsvalidering heeft geleid tot een daling van het aantal items van 63 naar 52. Het definitieve instrument van 52 items bevat 21 items voor gangen, 17 voor de huiskamer, en 14 voor de badkamer.

Concluderend kan gesteld worden dat systematisch verzamelde informatie over de verpleeghuisomgeving en de bewustwording van de zorgprofessionals en de technische staf omtrent de relatie van de omgeving met het visueel functioneren een middel is om de oogzorg te verbeteren en omgevingsgerelateerde problemen voor kwetsbare ouderen in het verpleeghuis te bespreken en op te lossen.

# 1

## Chapter 1 General introduction

## 1.1. Older adults and (day)light

*Older adults in the Netherlands*

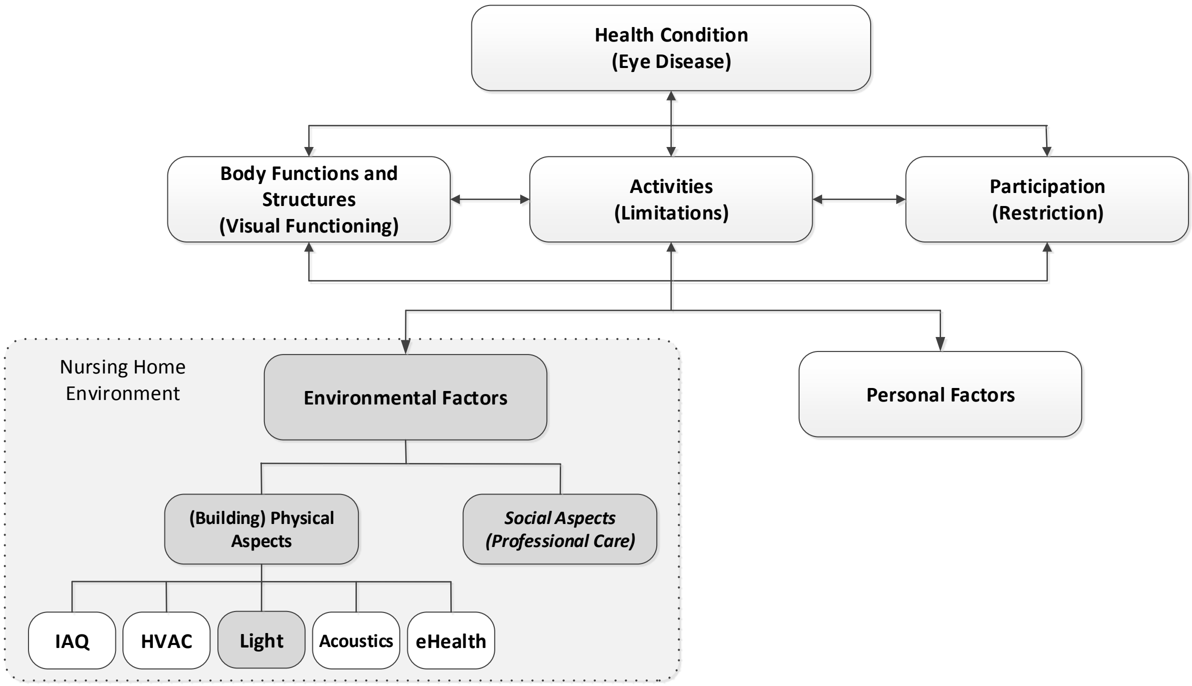
Similar to the world's population, the Netherlands is experiencing significant ageing. The percentage of the population aged 60 years or over in the Netherlands is currently 23.1%. Of the 102 countries in the world, Japan has the highest percentage of older persons (32%), and the Netherlands is 21st [1]. In addition, the number of frail elderly (65+) in the Netherlands is expected to expand to over a million in 2025. A fit older adult is one who is mobile and living independently, without major disorders. In contrast, frail older adults are often dependent on others, and many live in assisted living facilities or institutions. The risk of health problems in the frail elderly is much larger than in fit elderly persons. At the age of 65 and over, more than two-thirds of frail elderly adults have one or more chronic diseases [2]. In 2014, the number of older adults (> 65 years) residing in long-term care facilities in the Netherlands was 244,794 [3].

Multimorbidity increases with age, but it increases even more with increasing frailty such as in nursing home residents. Most nursing home residents are very old (>80 years), and their common morbidities are Alzheimer's disease and other types of dementia, cerebrovascular accidents, malignancies, neurologic disorders such as Parkinson's disease and multiple sclerosis, and mobility problems due to hip fractures or other locomotor disorders [4]. Vision disorders are also a relevant chronic disability [5].

*(Day)Light*

The World Health Organization's International Classification of Functioning, Disability and Health (ICF) framework illustrates that several contextual factors (environmental, personal and health-related factors) influence people's activities and participation (Figure 1.1.).

As shown Figure 1.1., the ICF framework [6] distinguishes building physical aspects such as light (e240), sound (e250) and air quality (e260) as components that influence people's functioning [7,8]. This distinction is part of the theme of Quality of Life of the department of the built environment at TU/e and is incorporated as part of "Building Healthy Environments for Future Users", which addresses environmental factors including the following: Indoor air quality (IAQ), Heating Ventilation and Air Conditioning (HVAC), Light, Acoustics and eHealth to create healthy environments.




IAQ = Indoor Air Quality, HVAC = Heating Ventilation and Air Conditioning

Figure 1.1. ICF model (WHO, 2001) building-related environmental factors, by Kort [7].

In this thesis, the focus is placed on the light conditions of the nursing home environment. For human beings, light is essential for basic vision, but light also plays a role in regulating important biochemical processes [9-11].

## 1.2. Light conditions, frail older adults, environment and health

Light influences health in a positive as well as a negative way [11-18]. Light can be described as radiation that causes a visual sensation. Light that can be detected by the human eye ranges between 380 nm (ultraviolet) and 780 nm (infrared) [19, 20]. The total flow of energy emitted by a source is called radiant flux and is measured in Watts. However, luminous flux is the most used quantity to measure light and is weighted according to the sensitivity of the human eye, as described in paragraph 1.3. Hence luminous flux, measured in lumen (lm), is adjusted to reflect the varying sensitivity of the human eye to different wavelengths of light. The density of light reaching a surface is measured in lx. The difference between one lumen and one lux is that lux compensates for the surface. The illuminance (E) is the areal density of the luminous flux and is measured horizontally ($E_h$) or vertically ($E_v$) in this thesis. The above described measurements of light are concerned with the density of light, not with the colour of light. Using the correlated colour temperature (CCT), the colour appearance of light can be quantified. According to Boyce [11], white light sources have a CCT ranging from 2,700 K (warm light) to 7,500 K (bluish, cool). The most commonly used fluorescent lamps are in the CCT range of 3,000-4,100K.

Aries [18] described in her thesis on “healthy lighting for offices” two available light sources (daylight through windows or skylights and electric lighting). This is also the case in nursing homes. The balance between daylight and electrical light differs by weather conditions and time of the year and day. The illuminance of daylight varies from 150,000 lx on a tropical sunny day to 1,000 lx on a cloudy day in winter in the Netherlands. The CCT varies from 40,000 K in a clear blue sky to 4,000 K on a cloudy day [11].

In the design of an environmental space, such as a nursing home, the proper quantity as well as quality of illumination is of importance. Quantity refers to task performance; a person needs enough light to complete a task. Quality refers to the distribution of brightness in space; effects such as glare, veiling reflections and visual comfort are issues of the quality of illumination. The parameters of light conditions addressed in this thesis are illuminance levels (lx) and correlated colour temperature (K).

Aries [18] states that *‘daylight, including high intensities and natural dynamics, is an important light source for healthy lighting’.* Occasionally, the luminous intensity of daylight is too low, or the daylight does not reach all areas where residents reside. Hence, electrical light can supply extra illuminance when and where it is needed. In a review, Aries et al. [21] proposed practical implementations for daylight and healthy building designs, such as allowing people to experience occasional exposure to the full radiation spectrum of high daylight levels (E> 2,000 lx) in a building’s rooms and providing automated blinding controls to meet personal comfort. Light inside of a nursing home consists of both daylight and electric light. Daylight enters the room naturally through windows. If the luminous intensity is too low, electric lighting can be added by using lamps or luminaires.

Another photometric quantity of light is luminance, which refers to the perception of brightness of a surface. The luminous ratio represents the luminance of one area divided by the luminance of another area. Extreme luminance contrast between visual fixation points will increase adaptation time for the eyes and effect visual performance [20].

Since 2012, the World Health Organization’s definition of health is not merely the *absence of disease or infirmity* but has been supplemented with “the state of complete physical, mental and social wellbeing” [22]. With this addition, the emphasis has shifted from a sole focus on disease towards the ability to adapt in the face of social, physical and emotional challenges.

Light impacts human beings physiologically and psychologically and can have a positive and comforting effect on health [11, 23]. Boyce [11] describes the effects of light in four classes: ‘light as radiation’, ‘light operating through the visual system’, ‘light operating through the circadian system’ and ‘light as a purifier of air’. The second and third classes are of interest in this thesis. Regarding ‘light operating through the visual system’, it is important to have enough light without producing discomfort or glare. Light conditions that cause discomfort lead to eyestrain and do not facilitate health. Moreover, for nursing home residents sufficient light (>750 lx) is necessary for leisure activities or tasks such as reading. For the third class, i.e., 'light operating through the circadian system', research shows that exposure to bright light at the right time can treat sleep disorders and seasonal depression [10-11]. High intensities of bluish light improved the sleep quality of Alzheimer patients in a nursing home [10, 12, 13]. *'Lighting that meets both the human visual and non-visual demands without causing visual discomfort is called 'healthy lighting'* [18].

### 1.3. The process of seeing

The process of seeing starts as light is passing the pupil through the vitreous body of the lens and reaching the retina (Figure 1.2. In the process of seeing, light that falls on the retina is transformed into signals that are subsequently sent via the optic nerve to the visual cortex of the brain [11].

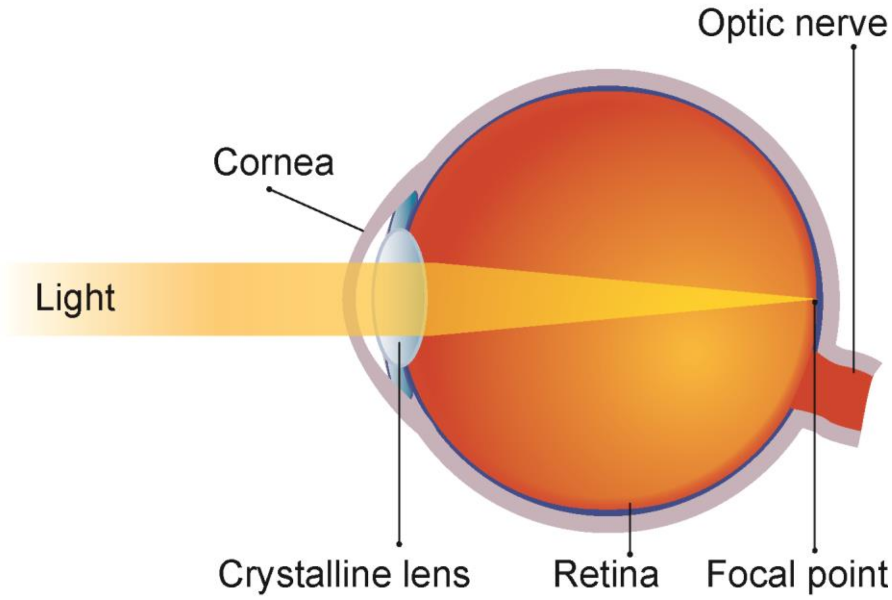



Figure 1.2. Light reaching the retina (from www. sharper visions.com)

Light elicits responses in the complex structure of the human retina and reaches several types of (photoreceptor) cells of the retina. Boyce describes the complex structure of the retina as having three layers:

- receptors: rods and cones;
- collector cells (horizontal and bipolar cells providing links between the rods and cones)
- retinal ganglion cells.

As described by Boyce [11] the axons of the retinal ganglion cells form the optic nerve, producing the blind spot where it passes the retina. In fact, the retina can be considered an extension of the brain, as the layers of the retina are directly connected to the brain by the optic nerve. At the end of this century, another type of photoreceptor cell (in addition to rods and cones) was discovered. This discovery expanded the function of light as being essential for basic vision to having a function in biochemical processes as well. A subset of the retinal ganglion cells, expressing the photo pigment melanopsin are light sensitive to blue light (short wavelengths 450-480 nm) [14,15]

In contrast to rods and cones, these photoreceptor cells send their information about the environmental lighting level to the suprachiasmatic nucleus (SCN) of the brain, which is connected to the pineal gland. The pineal gland produces melatonin, a sleep hormone that regulates the process of sleeping and waking. In addition to the sleep-wake rhythm, other body functions have a circadian rhythm, such as body temperature and hormone production, including cortisol. The combination of rods and cones, which are connected to the visual cortex of the brain, and the photoreceptor cells that are connected to the SCN lead to the dual function of light. One provides visual function related to tasks such as reading, navigating, and watching television (vision-related activities). These are called image-forming effects. The second function concerns the non-visual functions such as balancing sleep-wake rhythms and the biological clock. These are called non-image forming effects of light [11,16]. A well-functioning biological clock is essential to our health, especially for frail older adults with cognitive disorders such as dementia [17]. As described by Boyce [11], the visual photoreceptors (the rods and cones) dominate in different conditions. In photopic conditions (well-lit conditions), the cones dominate, while in scotopic conditions (low light conditions), the rods dominate.

### 1.4. Normal vision throughout life; visual impairments and eye diseases

Boyce [11] describes changes to the visual system with age such as reduced visual acuity, reduced sensitivity to light, reduced contrast sensitivity, colour discrimination and a greater sensitivity to glare. With increasing age, the group of people who reports vision loss expands. Vision loss can be due to refractive disorders, i.e., conditions in which the eye does not refract or bend incident light accurately into the retina to enable the best possible acuity. A natural progression in refractive error tends to occur with age. The use of visual aids including glasses and contact lenses may help. With increasing age, however, the group that reports vision impairment even when wearing glasses or contact lenses expands [23,24]. Some changes are due to the biological ageing of the eye: the amount of light (quantity) that reaches the retina reduces with increasing age. This is a result of normal ocular changes that result from ageing. Therefore, older persons require more light (quantity) to complete the same tasks when compared to younger persons [26, 27]. Consequently, a 60-year-old person needs three times the amount of light as a 20-year-old to comfortably complete a visual task.

Colour discrimination decreases with age. Blue, green and violet colours are mostly affected by the natural yellowing of the lens. This affects the ability to distinguish between colours, in particular shades of blue and green. Furthermore, blue objects tend to be observed as darker, and this might cause falls. Falling is a major problem in frail older adults and can result in serious physical and psychological consequences [28]. It has been reported that more than half of all nursing home residents fall each year, and approximately a quarter of those falls result in serious Injuries. Costello & Edelstein [29] included both medication and vision screening in a fall-screening examination. According to Evans & Rowlands [24], in Great Britain, high costs are associated with falls that are attributable to visual impairment, and adequate improvement of light conditions can partially compensate for impaired vision.

Additionally, the time needed to recover from the effects of glare is much longer for older than for younger adults [30]. Therefore, the challenge is to provide enough light without creating glare [26,27].

The risk of eye diseases increases with age, causing a decline in visual quality as well, such as reduced visual acuity, contrast sensitivity, peripheral vision loss, loss of the visual field, or suffering from glare.

The existing literature on vision impairment shows that as the population aged 65 years and over increases, the number of individuals suffering from visual impairments will increase as well [31,32]. Vision impairment refers to conditions that encompass the continuum from blindness to partial sight. Vision impairment indicates that a person's eyesight cannot be corrected to a normal level. Blindness refers to the condition of a lack of usable vision, with the exception of light perception [32]. According to the definition of the International Classification of Diseases -10 (ICD 10) of the World Health Organization (WHO), normal vision is defined according to the dimensions of VA = visual acuity (> 0,3) and the visual field [VF (> 30°)]. According to the ICD-10 [31], there are 4 levels of visual function, as shown in Table 1.1.

| **0.8 < VA** | 0.8 > VA > 0.3 | 0.3 > VA<br>30° **> VF** | **0.05 > VA<br>10° > VF** |
|---|---|---|---|
| **Normal Vision** | **Near normal vision** | **Low vision** | **Blindness** |

Table 1.1. Visual Acuity (VA) and the Visual Field (VF) from normal vision to blindness, based on the ICD-10 [34].

A visual acuity of 100% is described as VA = 1.0. A visual acuity of 0.1 (10%) means that a person is able to see an object at 6 metres while a person with normal sight can see from 60 metres. A person with a visual acuity below 30% or a visual field below 30 degrees suffers from low vision.

Four eye diseases cause a major proportion of blindness and low vision, which can all occur in the frail elderly population. These disorders are cataracts, macular degeneration, glaucoma and diabetic retinopathy [33, 35, 36].

Cataracts are a problem of the lens, whereas glaucoma is a problem of the optic nerve. Macular degeneration and diabetic retinopathy are retinal problems.

Of the four eye diseases, cataracts have the highest estimated prevalence in the Dutch population (943,000). Cataracts are the result of changes in the protein structure of the lens due to progressive thickening and opacification. For a person with cataracts, this results in increased sensitivity to glare, loss of contrast and visual acuity and a diminished visual field [37].

Glaucoma can be defined as a progressive optic neuropathy with a particular pattern of optic nerve damage and visual field loss that results from a variety of diseases affecting the eye. A major problem for glaucoma patients is peripheral field loss (tunnel vision). In daily life, this results in higher risks of falling and of bumping into objects that are outside one's field of view [38, 39].

Macular degeneration can be of two types: a dry type, which is due to atrophy of light-sensitive cells in the macula area, and a wet type, in which an increasing number of new blood vessels develop underneath the retina. As a result, the retina can break down with haemorrhage and destruction. This occurs in the area of the macula in particular and results in a loss of visual acuity and contrast.

Diabetic retinopathy results from new vessel formation and intra-retinal haemorrhage. These changes may cause retinal and visual damage that is experienced as scattered field loss, decreased visual acuity, increased sensitivity to glare and loss of colour and visual acuity [40]. Eye diseases have different implications for visual comfort, as shown in Table 1.2.

Table 1.2. Prevalence estimates of eye diseases in the Netherlands and implications for visual functioning based on Boyce [11].

| | Prevalence population-based estimation | Reduction in Visual Functioning | | | | | Sensitive to |
|---|---|---|---|---|---|---|---|
| Eye disease | | Visual Acuity | Contrast Sensitivity | Peripheral Vision | Visual Field | Perceiving Detail | Glare |
| Cataracts | 943,000 | x | x | | | | x |
| Glaucoma | 162,500 | | | x | x | | |
| Macular Degeneration | 100,000 | x | x | | | x | |
| Diabetic Retinopathy | 172,000 | | | | x | | |
| Implications for illumination conditions * | | >750 lx, without causing glare | | | | | |

*These illumination conditions are based on the European standard for workplaces (NEN-EN 12464-1) and the values stated by van Hoof & Schoutens and De Lepeleire et al. [41-43]

Table 1.2. shows that older adults have reduced visual functioning due to eye diseases. A high quality of illumination (such as a combination of daylight and artificial lighting >750 lx) without causing glare is important for this group of older adults. Aries et al. [44] report 1500 -4000 lx for reading tasks for the age of 60+, which should be compensated if the older adult suffers from visual impairments.

### 1.5. Visual comfort and the nursing home population

*Visual comfor*t is defined in the European standard EN12665 [45] as "*a subjective condition of visual well-being induced by the visual environment".*

It is possible to increase visual comfort and quality of life by improving environmental factors including light conditions [46]. Improved light conditions contribute to the prevention of falls and improved ambulatory ability, especially among older persons with low vision [46]. King et al. [47] interviewed 66 sight-impaired elderly individuals and found that severe sight loss was associated with long-term emotional distress and poor social functioning.

Furthermore, optimal contrast by the use of colours in areas where the older person spends a substantial amount of time can prevent falls [48].

In the nursing home population, eye problems and low vision are very common (> 40%) [49, 50]. Changes in visual functioning due to ageing and/or impairments establish a set point for the light conditions required to create visual comfort for frail elderly persons. [46, 51-53]. Regarding the building environment, the change in visual functioning can be compensated by adapting the light conditions, namely, the use of colours, contrasts and higher illuminances (if veiling reflections are avoided). Improved light conditions may lead to a number of benefits for nursing home residents, however till now insights and evidence is still limited.

Wang et al. [54] state that multidisciplinary programmes aiming to improve the quality of life of visually impaired older adults in nursing homes are needed. Quality refers to achieving safe, effective, efficient, person-centred care, and from a residents' point of view, the caregivers are a pillar of this care quality [55]. Consequently, for professional care, magnifying the task details for nursing home residents or adapting the light conditions can compensate for vision changes. As shown in the ICF framework (See Figure 1.1. ), professional caregivers in the nursing home are an important social aspect of providing eye-related care and achieving an environmental fit.

### 1.6. Aims of the thesis

Because of the importance of the nursing home environment for older adults, the aims of this thesis are, first, to explore the light conditions of the nursing home environment. Secondly, we explore the eye care provided to nursing home residents by performing eye examinations of nursing home residents, analysing their client files on eye care-related information, and studying the role of the nursing home physician in performing eye screenings, recording results in the client files, and collaborating with care professionals inside and outside of the nursing home. Finally, the content validity of a discussion tool (Environmental Observation tool for the Visually Impaired) for nursing home staff was determined. The items of the tool were established through a literature search and open observations in seven nursing homes.

These general aims are:

1. To explore the light conditions, measured in illuminance levels ($E_h$ and $E_v$) and correlated colour temperature, in Dutch nursing homes.
2. To describe the vision problems experienced by older adults residing in Dutch nursing homes in relation to the information recorded in their care reports.
3. To combine the age-related eye pathologies among nursing home residents with light conditions and the data recorded in client files.
4. To examine the role of nursing home physicians (NHPs) in eye care, as well as their collaboration with other professionals involved in eye care.
5. To develop and validate the content of a tool that is applicable to the discussion of environmental factors that influence the visual functioning of residents among professional caregivers.

## 1.7. Approach

In this thesis the ICF model is used as a framework to understand the consequences for environmental factors of reduced visual functioning of nursing home residents. As described in the ICF model (Figure 1.1.), in this study, the focus is on light as an environmental factor. In Figure 1.3., the ICF is applied to older adults suffering from visual functioning problems that affect their daily life.
The relationship between environmental factors, eye diseases and the visual functioning of nursing home residents is illustrated.

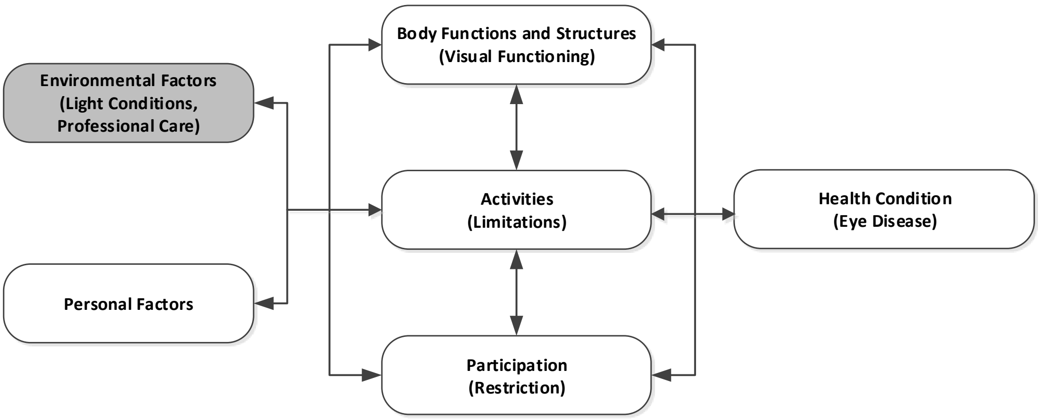



Figure 1.3. The International Classification of Functioning, Disability and Health: interactions between the components of ICF in visual functioning, based on the ICF [6].

As shown in the centre of the ICF model, the activities and participation of, for instance, an older person in a nursing home are related to their health condition (eye disease) and consequently the impaired visual functioning [47, 56]. The presence of eye disease, or the ageing eye, results in a loss of visual functions and subsequently in limitations in activities and restrictions in participation [57]. Within the ICF, the nursing home environment itself and the role of care professionals are considered to be environmental factors.
A modification of the light conditions, as a physical aspect, is important to improving visual comfort and to contributing to the quality of life of the residents. Furthermore, as a social aspect, the awareness of professional caregivers regarding the visual functioning (diagnosis and documentation) of the resident is a prerequisite for any modifications. Both aspects can be described as environmental factors, as shown in Figure 1.3. In this thesis, both the building's physical aspects (light conditions) and the social aspects (professional care) of the nursing home will be addressed.

## 1.8. Outline of the thesis

The objectives of the thesis are addressed in Chapters 2 to 6.
In chapter 2, the building physical aspects related to light and vision are explored. This chapter focusses on the light conditions in Dutch nursing homes. Single spot measurements are performed in terms of horizontal and vertical illuminances and correlated colour temperature and are related to a threshold for older adults.
Chapter 3 focusses on visual impairments and their documentation in client files. In a field study, nursing home residents receive an optometric examination, and the results are compared to the recorded information in their client files.
In chapter 4, data from the optometric examinations and the recorded visual problems are combined with the quality of light of the nursing home environment.
Chapter 5 focusses on the self-reported role of the nursing home physician in conducting eye examinations, recording information in client files and collaborating with other eye care professionals.
In chapter 6, the face validity of a developed tool for nursing home staff's awareness of the indoor visual environment is determined by experts in eye care and building engineering.

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# 2

## Chapter 2 Light conditions for older adults in the nursing home

**Also published in Building and Environment**

*Sinoo MM, van Hoof J, Kort HSM. (2011) Light conditions in the nursing home. Building & Environment, 46, 1917-1927. doi:10.1016/j.buildenv.2011.03.013*

**Abstract**

Over 40% of nursing home residents in the Netherlands are estimated to have visual impairments. In this study, light conditions in Dutch nursing homes were assessed in terms of horizontal and vertical illuminances and correlated colour temperature. Results showed that in the seven nursing homes vertical illuminances in common rooms fell significantly below the 750 lx reference value in at least 65% of the measurements.
Horizontal illuminance measurements in common rooms showed a similar pattern. At least 55% of the measurements were below the 750 lx threshold. The number of measurements at the window zone was significantly higher than the threshold level of 750 lx. Illuminances in the corridors fell significantly below the 200 lx threshold in at least three quarters of the measurements in six of the seven nursing homes. The correlated colour temperature of light fell significantly below the reference value for daylight of 5,000 K with median scores of 3,400 to 4,500 K. A significant difference in correlated colour temperature was found between recently constructed nursing homes and some older homes. Light conditions of the examined nursing homes were poor. With these data, nursing home staff have the means to improve the light conditions, for instance, by encouraging residents to be seated next to a window when performing a task or during meals.

## 2.1. Introduction

For many people, the loss of a part or all of their vision will become a reality as they grow older. In a recent epidemiological study in the Netherlands, over 40% of nursing home residents were estimated to have visual impairments [1]. Apart from the influence of ageing, there are pathological changes such as cataract, macular degeneration, glaucoma, and diabetic retinopathy that lead to low vision and eventual blindness. These impairments can affect several visual functions as well as daily functions in general [2-5].

Visual impairments stemming from biological ageing are diverse [2, 3, 6, 7]. First, the visual field area declines with age. This means that the portion of space in which objects are simultaneously visible is declining. Second, colour discrimination decreases with age. Blue, green, and violet colours are most affected by the natural yellowing of the lens. Blue objects tend to be observed as darker than they actually are. Third, adapting to the dark can be impaired for older adults when moving from light to dim environments. Fourth, older persons require more light than younger persons for carrying out the same tasks, as the amount of light that reaches the retina is reduced with increasing age [8]. A 60-year old person, therefore, needs three times the amount of light as a 20 year old to complete a visual task comfortably. And fifth, glare or light that is reflected directly back into the eye creates difficulties for older adults to see and should be minimised. The recovery time from the effects of glare is much longer for older than younger adults.

The abovementioned changes in vision do not happen overnight and are the result of the progress of biological ageing. After the age of 50, glare and low levels of light become increasingly problematic. People require more contrast for proper vision and can have difficulty in perceiving patterns. After the age of 70, fine details become harder to see and colour and depth perception may be affected [3].

Although visual impairments can result in the loss of basic visual abilities in over 50% of the cases, treatment of low vision or slowing down of a further decline are possible [1]. Nevertheless, the impact of vision loss in older adults affects daily care. It also influences the way daylight access and light conditions in the nursing home should be designed to meet the needs of older residents of these homes. Achieving adequate care and ambient light levels is a task involving all care and technical professionals in nursing homes. The most important benefits of sufficient light levels inside nursing homes are ‘visual’, i.e., supporting the ability to see and the performance of tasks such as reading and leisure activities. Aarts & Westerlaken [9] assessed light conditions in Dutch care homes and homes for older people. They found that conditions are too poor for proper vision. Similar results have been found and reported in the literature, for instance, in the United States by Hegde and Rhodes [10] and Bakker et al. [11], and in Belgium by De Lepeleire et al. [12]. In these studies, correlated colour temperature of the light and its spectral composition were not considered, and three of the studies [10-12] did not consider vertical illuminances. In addition, adequate lighting can also contribute to the prevention of falls. Especially in nursing home settings, falls are a major problem as there is a higher number of fall incidents among older people in long-term care versus those who live in the community. Falls are among those events in old age that mark the beginning of functional decline [13]. Moreover, light, particularly light with a wavelength of around 480 nm [5, 14-22], plays a role in regulating important biochemical processes, immunologic mechanisms, neuroendocrine control, circadian rhythmicity, and behaviour.

In this study, light conditions in Dutch nursing homes are measured, focusing on horizontal and vertical illuminances and correlated colour temperature in frequently used areas for daily functioning and traffic and transfers, including common spaces and corridors. The goal is to know the extent to which older adults are living in proper light conditions. With these data, we want to enhance the awareness among care professionals of how light conditions affect the daily lives of nursing home residents. Moreover, care professionals and technical staff could make appropriate improvements to the nursing home environment based on these data. In addition, improved light conditions will, in turn, improve the visual performance of the nursing home residents. This study is part of a larger project on visual impairments and light conditions in the nursing home.

## 2.2. Methodology

This study was based on literature research and measurements of illuminance and correlated colour temperature in nursing homes. In the following sections, the studied buildings, the measurement procedure, and the measurement equipment are described.

### 2.2.1. Study setting and study period

The nursing homes participating in this study are located in the area around of the city of Utrecht, which is situated in the centre of the Netherlands. The assessments were conducted in seven settings, which are part of four different care organisations (Table 2.1). These buildings consist of one or two wings. In total, 59 common or living rooms and corridors were assessed in this study. All nursing homes had windows with double glazing. The ratio of window surface and non-transparent wall surface of the outer façade was between 70 and 100%. All rooms were equipped with fluorescent lighting and some incandescent lamps for ambiance. The correlated colour temperatures (CCT) of the fluorescent lamps were 2,700 or 3,000 K.

In the first nursing home, only two common rooms were assessed. The wards of the second nursing home consisted a total of ten common rooms. The third building had two floors with four wards and two common rooms on each ward. The fourth nursing home was a large-scale building of eight floors with two common rooms on each floor. The fifth nursing home had three floors with wards consisting of two common rooms. The sixth nursing home had three floors with four common rooms on each floor, and the seventh nursing home had five common rooms all on the same floor. In all the included buildings, the residents live in small groups consisting of 8 to 12 persons spending time in one or more common rooms.

The buildings of the first care organisation were constructed in the mid-1970s, as were the two buildings of the third care organisation. Those of the second care organisation were built in the late 1990s. One of the facilities, however, had been renovated in 2009. Both nursing homes of the fourth care organisation were opened in the city of Utrecht in 2008 (Table 2.1).

Table 2.1. The seven nursing homes of four care organisations included in this study, their year of construction, date of measurements, sunshine duration hours and mean daily cloud cover (Meteorological data for the thirteen measurement days for the Royal Netherlands Meteorological Institute weather station in De Bilt, Region Utrecht, The Netherlands. Source: Royal Netherlands Meteorological Institute (KNMI); http://www.knmi.nl/klimatologie/daggegevens/download.html).

| Nursing home | Care organisation | Year of construction | Year of renovation | Orientation of common rooms | Measurement period [ddmmyy] | Sunshine duration [hours*] | Mean daily cloud cover [octants**] |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1976 | 1996 | North; East | 161009 | 4.8 | 6 |
| 2 | 1 | 1974 | - | South; South-West | 080110; | 2.9 | 6 |
| | | | | | 150110 | 0 | 8 |
| 3 | 2 | 1997 | - | North-East | 021109; | 2.4 | 5 |
| | | | | | 100210; | 3.1 | 7 |
| | | | | | 170210 | 3.7 | 6 |
| 4 | 3 | 1976 | - | West; East | 160310; | 3.1 | 7 |
| | | | | | 170310 | 8.3 | 6 |
| 5 | 3 | 1977 | 2009 | North-East; South-East | 090310; | 10.3 | 0 |
| | | | | | 120310 | 0.2 | 8 |
| 6 | 4 | 2008 | - | South; East | 230310 | 9.7 | 5 |
| 7 | 4 | 2008 | - | South; East | 180310; | 6.6 | 6 |
| | | | | | 190310 | 0 | 8 |

*calculated from global radiation

**9=sky invisible

The study was performed between October 2009 and the end of March 2010 during daytime between 10:00 and 15:00 hours. The first assessments were conducted in October and November 2009 in nursing home 1 and 3. In January 2010, nursing home 2 was assessed. In February 2010, the assessments in nursing home 3 were completed. In March, assessments were conducted in nursing homes 4 to 7 (Table 2.1). By measuring in autumn, winter, and early spring, the contribution of daylight to the indoor illuminances was kept at a minimum. Meteorological data on mean cloud cover on the measurement days are provided in Table 2.1. as well.

### 2.2.2. Measurements of light parameters

Light conditions were measured in places where older adults residing in the participating nursing homes spend most of their day, i.e., common spaces, such as group living rooms and corridors.

The assessment of light conditions consisted of measuring illuminance levels (E [lx]) and correlated colour temperature (Tc [K]) in a given location in the nursing home. Since the current study is a field study and environmental exposures are relevant to daily practice, all light measurements (illuminance level and correlated colour temperature) were taken in the daytime. These measurements include the contribution of daylight and reflect the light situation as encountered at the moment of observation. Illuminance level and colour correlated temperature were assessed using a Konica Minolta chromameter CL-200 by Konica Minolta Sensing Inc. The measurement range of this instrument is 0.1 to 99,990 lx, but the measurement thereof may depend on the colour of the measured light. The instrument can display correlated colour temperature values from 2,300 to 20,000 K; values below 2,300 K may contain a slight bias of unknown size, which has not been corrected for in this study.

The measurements of illuminances and correlated colour temperature were conducted in a vertical direction at the eye (also known as corneal or ocular illuminance), gazing direction, $E_v$, at a height of 1.6 m (Figure 2.1.), and in a horizontal direction (at table level at a height of 0.9 m and at chair level at a height of 0.6 m, $E_h$). These heights represent the older adults standing upright or walking around common rooms and corridors as well as performing a task or holding something in their laps while seated at a table. In the corridors, the measurements were conducted in a vertical direction.

#### 2.2.2.1. Assessments of illuminance

Since the direction of light at the retina plays an important role in non-visual effects of lighting, the vertical illuminance at the position of the eye was measured taking into account the participant's viewing direction and angle (Figure 2.1.) as follows from the luminance of a scene (Lscene). In theory, there exists a unit of conventional retinal illuminance (Eretinal), the troland unit [Td] [24, 25], which corrects light measurements by scaling outcomes by the effective pupil size. However, as this study does not correct for visual impairments, including the effects on the pupil that are due to biological ageing, the troland has not been used as an outcome unit. Findings in this study are reported as hypothetical ocular or corneal illuminance levels, not retinal illuminance levels (Figure 2.1).

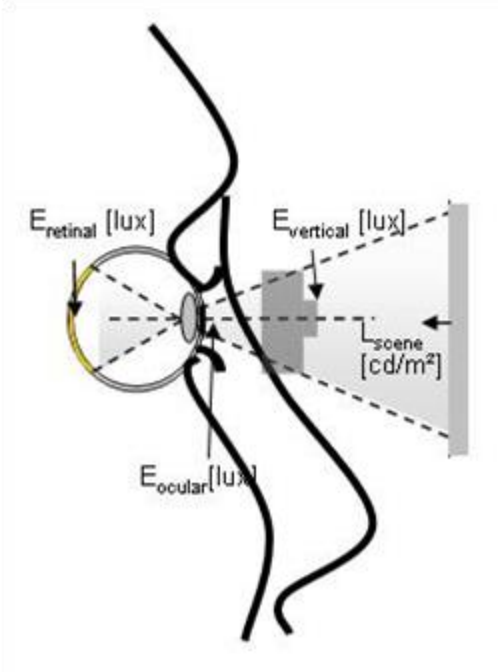


Figure 2.1. The difference between ocular and retinal illuminances when measuring vertical illuminances [23]. In courtesy of Dr M.B.C. Ariës, Eindhoven University of Technology.

Measurements of vertical and horizontal illuminance levels were separated in zones which are differentiated according to the distance from the windows (Figure 2.2.). The orientation of the different rooms can be found in Table 2.1. The ‘window zone’ is defined as situated within 1 to 3 m from the windows. The ‘central zone’ is situated within 3 to 5 m from the windows. The rear zone is situated at the back of the common room, i.e., more than 5 m from the windows.

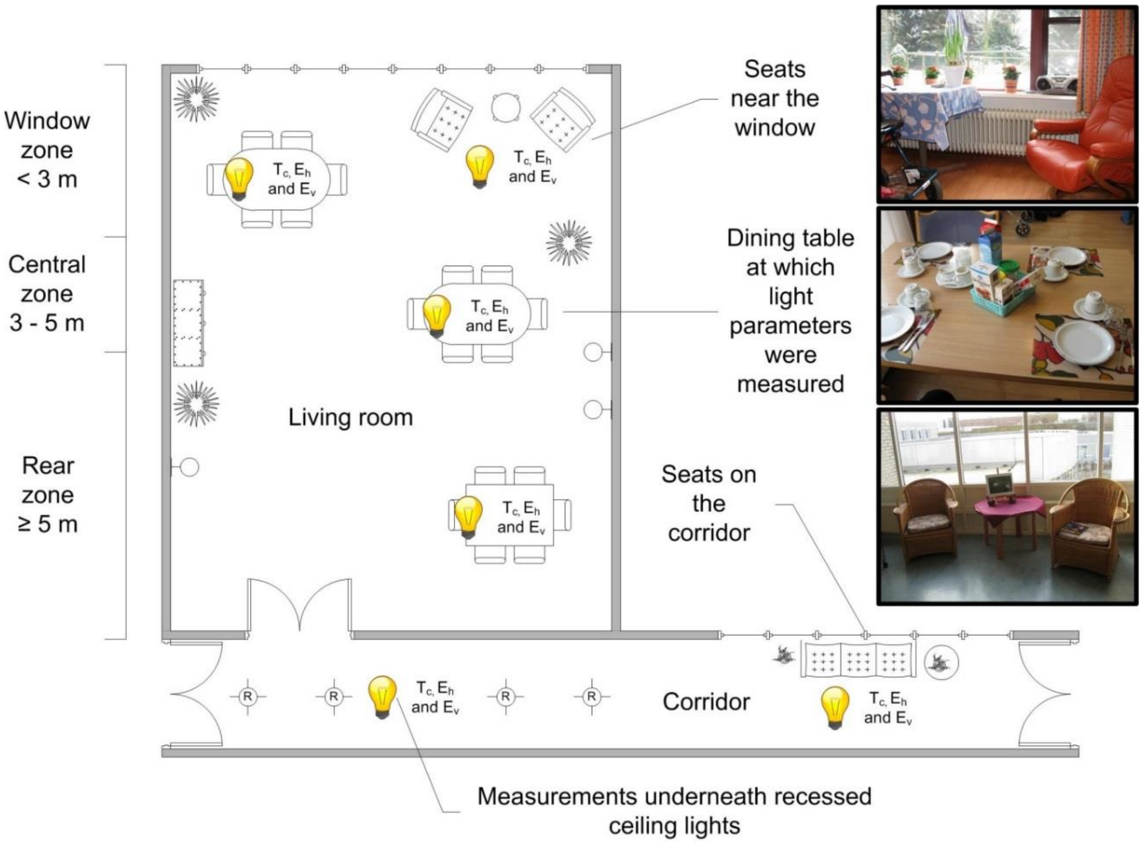


Figure 2.2. Schematic overview of measuring locations in the nursing home, showing a common room and a corridor.

In the common rooms, three zones were distinguished: the window, central and rear zones. In some corridors, seats were present near windows. In such cases, these corridor seats were treated as part of the corridor measurements. The three inserted figures show seats and a dining table as encountered during the measurements. Three lighting parameters were measured near these seats and at these tables, as is illustrated by the light bulbs in the figure. ($T_c$ = colour temperature, $E_v$ = vertical illuminance, $E_h$ = horizontal illuminance)

In the corridors, measurements of illuminance levels were conducted in a vertical direction at eye gazing level at a height of 1.6 m. Single spot measurements were conducted at several points, under and in between the light sources in corridors. All corridors in nursing homes were situated in the inner part of the building with a window at the end of the corridor. An exception was nursing home 3, in which a corridor was situated at a window side of the building; moreover, there was a sitting area in this corridor.

The observed illumination conditions were compared to the values given in a guideline by the Dutch Society for Illumination (Nederlandse Stichting Voor Verlichtingskunde, NSVV) [26], and compared to the values stated by van Hoof & Schoutens [27] and De Lepeleire et al. [12] (Table 2.2.).

Table 2.2. Recommended horizontal illuminances per room according to van Hoof & Schoutens [27]. Generally, the correlated colour temperature of the light sources should

be between 2,700 and 3,000 K, in accordance with personal preferences. Recommendations by De Lepeleire et al. [12] based on a 55% increase of levels stated in the European Standard Lighting of workplaces are included in the comments. Taken and adapted from van Hoof et al. [3].

| Location | $E_h$ [lx] | Comments |
|---|---|---|
| Living room | 200-300 | |
| Living room, near seat | 1,000-2,500 | At places where a great deal of time is spent, Tc should be between 6,500 and 8,000 K. |
| Dining room (table level) | 500-1,000 | |
| Hobby space | 500-1,000 | De Lepeleire et al. [12] recommend approximately 775 lx |
| Corridors | 100-200 | De Lepeleire et al. [12] recommend 200 to 300 lx during the day and 50 to 80 lx during the night. |

The available guidelines for light for older people, however, do not distinguish between horizontal and vertical illuminances. In addition, the values stated in the literature mainly concern horizontal illuminances. In practice, the illuminances in the gazing direction are those that are relevant as those illuminances reflect the actual exposure. Therefore, vertical illuminances are included in the current study as well, using the same threshold values as for horizontal illuminances. These two illuminances are not equal and cannot be derived from one another in indoor settings. The illuminances depend on daylight access and the output of lighting systems and dimensions of luminaires.

Nursing homes do not only have a residential function, i.e., providing a home to older adults who require a high level of care, but are also workspaces for nursing staff and other professionals. The European standard EN 12464-1 [28] deals with lighting of indoor work places. The standard specifies illuminances for health care facilities, such as waiting rooms, corridors, examination rooms, and spaces for diagnostics in hospitals. Nursing homes are not included in this standard. The standard specifies a value of 200 lx for corridors during daytime, and this value was also used as a limit in the current study, i.e., as a threshold for light exposure of residents. For common rooms for treatment, values between 300 and 500 lx are advised although for specific eye tasks higher illuminances are provided [28]. The standard does not specifically include correlated colour temperature for health care facilities.

As older adults spend most of their time in the communal living room, enjoying their meals and doing leisure activities, the basic illuminance level for these living areas are recommended to be between 500 lx and 1,000 lx [26]. In this study, we set the critical threshold at the mean value of 750 lx and also took the upper level of 1,000 lx as a second set-point. Higher illuminances, hypothetically, of at least 2,500 lx for older adults (Table 2.2.) are a requirement for certain non-image forming (NIF) effects. These effects include the suppression of melatonin, circadian phase shifts, certain repercussions on human physiology in terms of heart rate, core body temperature, and brain activity, as well as effects on mood and behaviour [17,18,29]. In corridors, the threshold value for vertical illuminance was set at 200 lx, as mentioned previously.

#### 2.2.2.2. Assessments of correlated colour temperature

Correlated colour temperature of the light to which nursing home residents were exposed is explicitly included in this study, for the importance high- correlated colour temperature light may have in relation to non-image forming (NIF) effects.

Exposure to light (λ ~ 480 nm) is the most important stimulus for synchronising the biological clock [3]. The circadian system, which is orchestrated by the hypothalamic suprachiasmatic nuclei (SCN), influences virtually all tissue in the human body. In older adults, the orchestration by the SCN requires ocular light levels that are significantly higher than those required for proper vision. An additional problem is formed by the ageing of the eye that leads to opacification and yellowing of the vitreous and the lens, limiting the amount of bluish light reaching the retinal ganglion cells [14].

Górnicka [30] calculated the NIF effects of lamps for office situations. She found that the higher correlated colour temperature of light, the more NIF output the light yields (Figure 2.3.).

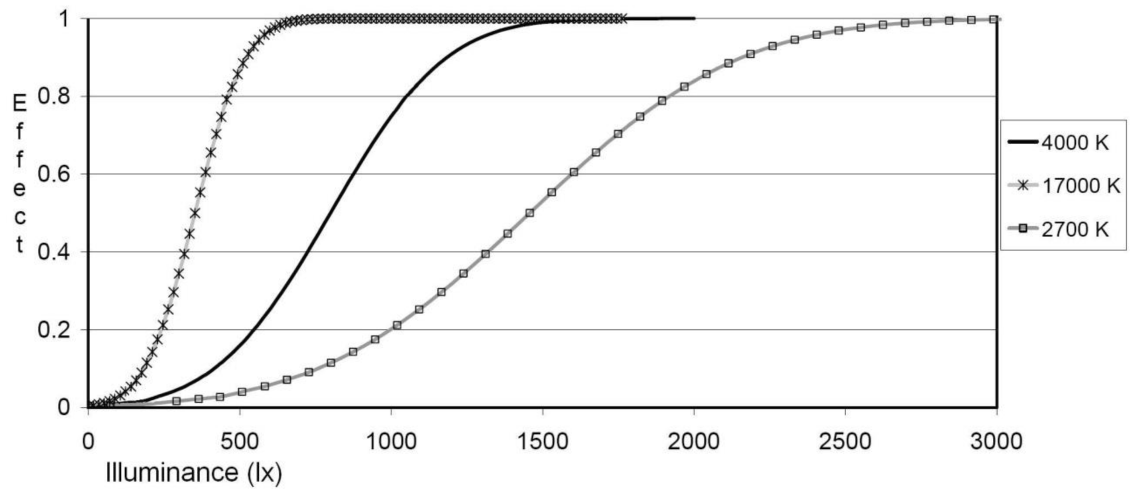


Figure 2.3. Hypothesised size of NIF effects of light during daytime for different illuminances at the eye and different correlated colour temperatures. Taken and adapted from Górnicka [30].

The correlated colour temperature provides a first indication of the spectral distribution or composition of the light, but the correlated colour temperature is of course not the same as the spectral composition. Due to the aforementioned opacification and yellowing of the vitreous and the lens, and thus increased filtering of the short wavelength light, this ratio may differ in older people. From the literature we have some hints [26,27] to compare the single spot measurements to a reference value, the outcomes of the correlated colour temperature assessments are compared to a reference value for daylight of 5,000 K.
Moreover, the NSVV guideline [26] and van Hoof & Schoutens [27] (Table 2.2.) mention a correlated colour temperature of 6,500 K as a lower threshold for lighting in practice to allow for NIF effects to take place. Therefore, the light conditions found in the nursing homes were compared to this value, too.

#### 2.2.2.3. Combined assessments of illuminance and correlated colour temperature in relation to the perceived ambiance

The Kruithof curve [31] relates the illuminance and correlated colour temperature of visually-pleasing light sources. This curve depicts the connection between correlated colour temperature and illuminance in relation to the perceived ambiance. The colour sensation of a given light mixture may vary with absolute luminosity. This is because both rods and cones are active at once in the eye, with each having different colour curves, and rods taking over gradually from cones as the brightness of the scene is reduced. The data found in this study is superimposed over the Kruithof curve in order to assess the ambiance of the light conditions found in the seven nursing homes.
Boyce [32] has already stated that the work underlying the Kruithof curve has not been extensively reported, and the validity of Kruithof's boundary conditions is open to discussion. As the original boundary conditions have not been described in Kruithof's original work [31], the boundary conditions taken for this study are a reconstruction of the original curve. To our knowledge, this is the first study to use the Kruithof curve for the assessment of light conditions in nursing homes. In practice, when there is sufficient time for chromatic adaptation to occur, the recommendations based on the Kruithof curve are unnecessarily restrictive [32]. Moreover, the correlated colour temperature (CCT) of fluorescent lamps is a minor factor in determining satisfaction with the lighting of an office; illuminances are more important [32].

### 2.2.3. Statistical analyses

Data analyses were carried out using SPSS 17.0 for Windows. The critical p-value was set at 0.05 for comparisons between the seven nursing homes, and the Bonferroni correction was applied setting the critical p-value at 0.008. Non-parametric statistics (two-tailed Kruskal-Wallis H-test and Mann-Whitney U-test) for independent samples were employed to test differences in correlated colour temperature levels in the seven nursing homes. A two-tailed non-parametric sign test was employed to explore the differences in measured illuminances and correlated colour temperatures in the nursing homes compared to their reference value. The critical p-value again was set at 0.05.

#### 2.2.4. Ethics

Managers of the participating organisations agreed on the light measurements from the start of the project and were involved in the planning of the project. Professional and family carers were invited for an information meeting at the start of the project after the management of the care organisations had agreed to participate. Two out of the seven nursing homes (nursing homes 4 and 5) asked for additional informed consent from the family board, which was given on request. During data collection, the professional and family carers who were present, along with the residents, were informed about the assessment protocol. Daily activities were not disturbed nor hindered by the measurement procedure. Results of the light conditions of each nursing home were discussed with the staff of that nursing home.

### 2.3. Results

In 59 common rooms, data were collected measuring illuminances (vertically as well as horizontally) and correlated colour temperature as mentioned before. The data as collected for illuminance in the nursing homes have been included in Tables 2.3. and 2.4., as well as in Figures 2.4. and 2.5. Figure 2.4. shows correlated colour temperature measurements.

#### 2.3.1. Illuminances

Results show that 55% or more measured vertical and horizontal illuminances in the common rooms of the nursing homes fell below the 750 lx threshold derived from the NSVV guideline [2], as will be illustrated in the following sections.

Table 2.3. Light conditions in the seven nursing homes: illuminances in common spaces (minimum and maximum levels) compared to a threshold level of 750 and 1,000 lx (frequency of measurements below threshold in relation to the total number of measurements); illuminances in corridors compared to a threshold level of 200 lx; and minimum, median and maximum correlated colour temperatures, and comparisons to 5,000 and 6,500 K. Number of measurements are given as part of the total number of measurement points per nursing home.

| Nursing home | Number of common rooms measured (N = 59) | Ev at the eye gazing direction in common rooms | | | | Eh at table height or lap level in common rooms | | | | Ev in corridors | | | Tc [K] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emin [lx] | Emax [lx] | N < 750 lx | N < 1 klx | Emin [lx] | Emax [lx] | N < 750 lx | N < 1 klx | Emin [lx] | Emax [lx] | N < 200 lx | Min | Median | Max | N > 5,000 K | N > 6,500 K |
| 1 | 2 | 110 | 850 | 13/14 92% | 14/14 100% | 290 | 460 | 5/5 100% | 5/5 100% | 20 | 250 | 9/12● 75% | 2308 | 3400 | 5233 | 2/31 7% | 0/3 0% |
| 2 | 10 | 30 | 2750 | 88/94 94% | 89/94 95% | 60 | 2500 | 28/32 88% | 28/32 88% | 6 | 240 | 13/14 93% | 2580 | 3800 | 7480 | 39/141 28% | 2/141 1% |
| 3 | 8 | 90 | 3060 | 59/90 66% | 68/90 76% | 200 | 1880 | 28/41 68% | 32/41 78% | 9 | 260 | 16/21 76% | 2013 | 4500 | 9459 | 50/151 33% | 14/151 9% |
| 4 | 16 | 20 | 1590 | 170/179 96% | 176/179 98% | 20 | 3670 | 40/50 80% | 45/50 90% | 13 | 250 | 87/89 98% | 2087 | 3800 | 5749 | 16/286 6% | 0/286 0% |
| 5 | 6 | 40 | 1230 | 77/81 95% | 78/81 96% | 50 | 3330 | 40/43 93% | 40/43 93% | 38 | 2450 | 47/61 77% | 2686 | 3300 | 6044 | 10/187 5% | 0/187 0% |
| 6 | 12 | 150 | 3700 | 78/120 65% | 82/120 68% | 170 | 3200 | 21/38● 55% | 27/38 71% | 14 | 1120 | 15/45● 33% | 2030 | 4300 | 6161 | 43/204 21% | 0/204 0% |
| 7 | 5 | 70 | 1770 | 41/54 76% | 46/54 85% | 100 | 3660 | 19/26 73% | 20/26 77% | 18 | 740 | 19/21 90% | 2738 | 4300 | 6295 | 18/101 18% | 2/101 2% |
| Total | 59 | | | | | | | | | | | | | | | | |

● Nursing homes with *not* a significantly high number of measurement outcomes below the threshold. Two-tailed sign test, $p < 0.05$

Table 2.3. shows that nursing home 3 and 6 had the fewest measurements, which fell below the threshold of 750 lx (min-max 20-3,700 lx), of all seven nursing homes; i.e., 59 out of 90 (66%) and 78 out of 120 (65%) measurements, respectively. All the other nursing homes showed a higher number of measured vertical illuminances that fell below the 750 lx threshold (> 75%). In nursing home 1 almost all measurements (13 out of 14) were lower than 750 lx. Even a higher percentage of the vertical measurements were below 1,000 lx, and, accordingly, every nursing home shows a higher percentage of measurements below 1,000 lx as compared to the measurements below the threshold of 750 lx.

All nursing homes showed a significantly high number of measurements below 750 lx. Horizontal measurements at table level or on the lap at chair level showed the same results, and again nursing homes 3 and 6 tended to score best in relation to the threshold level of 750 or 1,000 lx. Only 21 out of a total of 38 measurements (55%) for nursing home 6; and 28 out of 41 measurements (68%) for nursing home 3 were lower than 750 lx (min-max 20-3,670 lx). However, only nursing home 6 did not show a significantly high number of measurements that fell below the threshold of 750 lx. As the threshold was set on 1,000 lx, even a higher percentage of the measurements at the horizontal level fell below this point, and, accordingly, every nursing home shows a significantly high number of measurements below 1,000 lx. In the corridors of the nursing homes, 75% or more of the measurements fell below the threshold level for corridors, which was set on 200 lx.

Nursing home 6 is the exception; in this nursing home, 'only' 15 out of 45 of the measured illuminances were lower than 200 lx, which makes this the nursing home with the most illuminated corridors. In nursing home 2 only 12 measurements were taken in the corridors. A relatively high number of measurements was not significantly lower than 200 lx. In all the other homes, light conditions were less favourable as 75% of the measurements or more fell below the threshold of 200 lx. The measured illuminances ($E_v$ and $E_h$) in the various nursing homes can also be differentiated by the zone in which the measurements took place (Table 2.4.).

Table 2.4. Vertical illuminances at the eye gazing direction in all nursing homes. For the common rooms, the threshold limit for illuminance was set at 750 lx. For corridors, the threshold limit for illuminance was set at 200 lx. Horizontal illuminances at table level or on the lap when seated for three zones are given for a threshold level of 750 lx. Absolute frequencies and percentages of vertical and horizontal measurements of illuminances in the window, central and rear zones in relation to the threshold limit of 750 lx for common rooms and 200 lx for corridors.

| Ev [lx] | Zone in the nursing home | | | | Eh [lx] | Zone in the nursing home | | |
|---|---|---|---|---|---|---|---|---|
| | Common Rooms | | | Corridors | | Common Rooms | | |
| | Window zone | Central zone | Rear zone | | | Window zone | Central zone | Rear zone |
| < 750 | 157 (70%) | 293 (88%) | 76 (100%) | | < 750 | 60 (59%) | 79 (90%) | 29 (91%) |
| > 750 | 66 (30%) | 40 (12%) | 0 (0%) | | > 750 | 41● (41%) | 9 (10%) | 3 (9%) |
| < 200 | | | | 206 (78%) | | | | |
| > 200 | | | | 57 (22%) | | | | |
| Total | 223 | 333 | 76 | 263 | Total | 101 | 88 | 32 |

● Zones with a number of measurement outcomes not significantly lower than the threshold. Two-tailed sign test, $p < 0.05$

Again, a high percentage of 70% or higher (157 of a total of 223 measurements at the window zone) of the measurements showed vertical illuminances that were below the threshold of 750 lx. Horizontal measurement at the window zones was an exception. The number of measurements significantly higher than the threshold at the window zones was higher as compared to the central and rear zone. In these zones, 90% or more of the number of measurements fell below the threshold level of 750 lx.

A higher percentage of illuminances that were measured at horizontal level in the window zones exceeds the threshold level of 750 lx, namely 41% (or 41 out of 101 measurements in total). Horizontal measurements were assessed at table level or lap level in a seated position in a chair. This means that a higher percentage of measurements that were taken at the tables that were placed in the brighter zones of the common room exceed the threshold of 750 lx. Placing tables in the direct window zone provides the residents with the most favourable light conditions. In the central and rear zones of the nursing homes, almost all measured horizontal illuminances fell below the threshold limit of 750 lx (79 out of 88 for the central zone; and 29 out of 32 for the rear zone).

### 2.3.2. Colour temperature

The median correlated colour temperature scores of the seven nursing homes have been determined (Table 2.3.), along with the minimum and maximum correlated colour temperatures. In all nursing homes, the median correlated colour temperature of the light is lower than the reference value for daylight, which was set on 5,000 K. The correlated colour temperatures ranged roughly between 2,000 and 9,500 K. In terms of matching daylight conditions, nursing homes 3, 6 and 7 come closest to this reference value of 5,000 K, but still fall about 500 to 700 K short (Figure 2.4.).

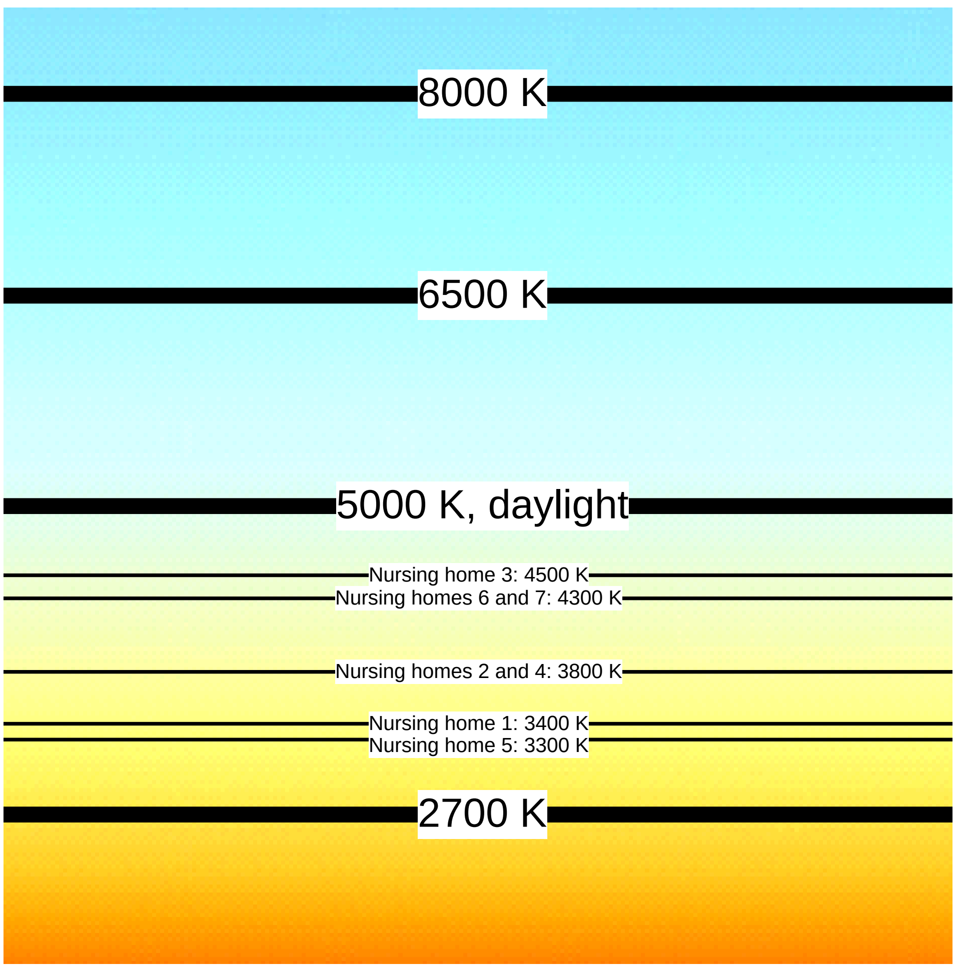


Figure 2.4. Medians of measured correlated colour temperature in the seven nursing homes compared to the threshold limits of 5,000 (daylight); 6,500 and 8,000 K [26,27] and the common CCT of 2,700 K of fluorescent lamps.

In terms of the recommendations by van Hoof & Schoutens [27] that the correlated colour temperature should be between 6,500 and 8,000 K, it becomes clear that the correlated colour temperatures inside the nursing homes fall even farther below these values. At the same time, conditions between the seven nursing homes are not similar. A Kruskal-Wallis H-test for independent samples showed that there is a significant difference in correlated colour temperatures between the seven nursing homes ($p < .05$).
The differences in measured correlated colour temperatures in the seven nursing homes are explored by using a Mann-Whitney U-test for two independent samples (Table 2.5.).

Table 2.5. Exploration of differences in correlated colour temperatures between the different nursing homes; $p < .008$ (according to the Bonferroni adjustment).

| Nursing home | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | - | | | | | | |
| 2 | * | - | | | | | |
| 3 | * | ns | - | | | | |
| 4 | * | ns | ns | - | | | |
| 5 | * | * | * | * | - | | |
| 6 | * | ns | ns | * | * | - | |
| 7 | * | ns | ns | * | * | ns | - |

* = significant; ns = not significant

Nursing home 1 appears to have a significantly lower correlated colour temperature as compared to all the other facilities. Nursing homes 6, 7 and 3, which came closest to the 5,000 K reference value for daylight, show no significant differences when compared to each other. Although in nursing homes 2 and 4 the median value for correlated colour temperature was 3,800 K, nursing home 4 differs significantly from nursing homes 5, 6 and 7, whereas nursing home 2 is not statistically different. These differences may be caused by the larger range of scores of nursing home 2 as compared to nursing home 4.
The sign test was used to explore the differences in measured correlated colour temperatures in the nursing homes from the 5,000 K reference value for daylight. All nursing homes had a significant number of measurements that fell below 5,000 K.

### 2.3.3. Combined assessments of illuminance and correlated colour temperature in relation to the perceived ambiance

The illuminances and correlated colour temperatures measured inside the seven nursing homes also contribute to the ambiance or atmosphere inside these facilities. When plotting all the data of this study in the Kruithof curve (Figure 2.5.), about 40% of the data points fall below the lower boundary. This means that these conditions are too dim and cold.

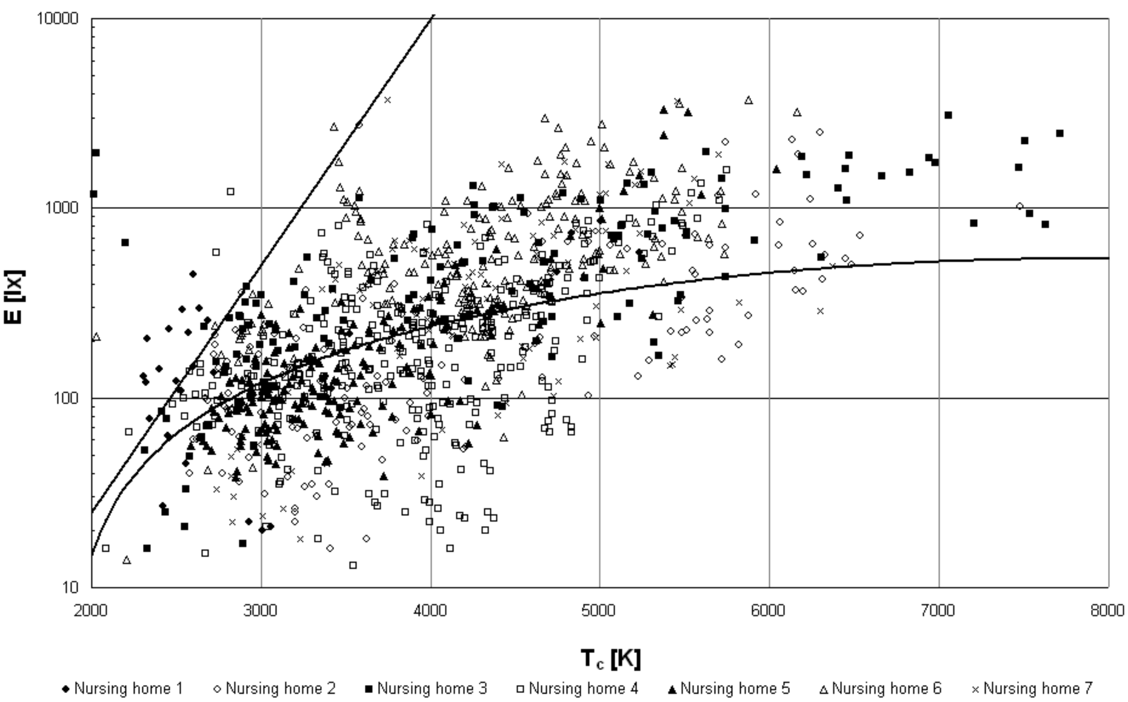


Figure 2.5. The data points, combining illuminance (y) and correlated colour temperature (x) of the light inside the seven nursing homes, depicted in the reconstructed Kruithof curve [31], showing the lower and upper boundaries for acceptable ambiance.

The majority of data are within the boundaries of pleasant light conditions. The maximum values for every nursing home are within the limits of being perceived as a cold ambiance. The few data points in the upper left corner are said to reflect an overly colourful environment. Apart from the lighting conditions being too dim for NIF effects to take place, the lighting conditions are too dim for visual comfort and not pleasing according to the Kruithof curve.

### 2.4. Discussion

In the following sections, the design of lighting for nursing homes in relation to higher illuminances, the impact of correlated colour temperature of ambient light and its relation to interior design and NIF effects, and the benefits of lighting and ethics are discussed. Earlier studies, for instance, Charness & Dijkstra [33], have already shown that living and public areas for older adults often have poor lighting and thus poor light conditions. This study makes clear that light conditions in the living areas for older adults are poor due to both low illuminances and low correlated colour temperature of the light.

#### 2.4.1. Methodological issues

Illuminance and correlated colour temperature thresholds are not specified for nursing homes in official international documents. The choice for a certain correlated colour temperature of light(ing) is not prescribed in much detail in the available literature. If white light is required for reasons of user acceptability, then either daylight or one of the very high correlated colour temperature discharge light sources would be most effective [34]. The ageing of society may correlate with an increase in the number of co-morbidities (the presence of one or more disorders/diseases in addition to a primary disorder/disease) meaning that more people may need nursing home services. Therefore, it is relevant that future studies should examine threshold levels in nursing homes both for residents as well as nursing home staff. In this study, measurement points (locations) were chosen in relation to the positioning of furniture, such as chairs and tables. No corrections were made for orientation of the building or for the presence of trees in front of the windows as the actual light conditions the residents were exposed to mattered in this study.

#### 2.4.2. Illuminances for older adults

The basic strategies for creating a healthy living environment for older adults with low vision include: (i) increasing illuminance levels, (ii) controlling brightness, glare and luminance ratios, (iii) using clear and contrasting colours, (iv) arranging a convenient layout of spaces and (v) realising 'clear acoustics' [2,23,35]. As to clear acoustics, Heylighen et al. [36, p.283] state that "[…] good conditions for auditory communication require attention to the acoustic qualities of a space […]. It is especially important for people with a hearing or visual impairment, but also for the growing group of [older] people or when an extra language effort is needed." In practice, however, Aarts & Westerlaken [9] have shown that light levels (vertical illuminances) inside care homes and homes for older people in the Netherlands, even during daytime, are too low to allow for proper vision and NIF effects.

Paradoxically, the subjects in their study were satisfied with their lighting conditions that fell below standard. This discrepancy, however, can be explained by inherent biases in satisfaction research among older adults [10]. Similar results have been found and reported in the literature, for instance, in the United States by Bakker et al. [11], and in Belgium by De Lepeleire et al. [12]. In these previous studies, correlated colour temperature of the light and its spectral composition were not considered either, and the majority of studies did not consider vertical illuminances. Lindner et al. [37] studied the subjective lighting needs of people with cataract and glaucoma. The study showed that eye diseases can have an impact on the preferred illuminance levels, which can be hundreds of lux-units lower than those preferred by healthy subjects. As to correlated colour temperature, the so-called warm white light was preferred by all groups.

As mentioned earlier, older people may suffer from low vision due to both the effects of biological ageing and several pathologies, for instance, a decreased crystalline lens transmittance and pupil area. This is one of the reasons why lighting levels in nursing homes should be much higher than they are today. This is illustrated by Turner et al. [22], who stated that illuminance levels of 128 to 320 lx; 184 to 460 lx; 256 to 640 lx; 400 to 1,000 lx; 536 to 1,340 lx; and 656 to 1,640 lx would be insufficient in 45, 55, 65, 75, 85 and 95 year old adults, respectively. These illuminance levels are much higher than average residential light levels and the levels found in this study. These lower levels point to the need for light levels in nursing homes to be substantially higher than they are today. The aforementioned illuminances [18] were not considered for the measurements in this study as the specific age of potential residents was not included, and existing standards and guidelines were used for setting threshold levels.

In addition to vision problems, Turner et al. [22] stated that insomnia in older people may be aggravated by poor light levels. Threshold intensities of at least 2,500 to 3,000 lx have been shown to reduce or alleviate insomnia; increase sleep efficiency, total sleep time, and restorative slow-wave sleep; and improve daytime vigilance and sleepiness [22]. Such high levels were hardly encountered in the seven nursing homes included in this study, apart from values measured in the direct window zone. This might imply that the residents suffering from insomnia may do so (partly) because of low ambient light levels. At the same time, their condition may be aggravated because of their lack of exposure to bright light brought about, for instance, by not going outdoors.

### 2.4.3. Including correlated colour temperature in lighting schemes

Apart from the abovementioned solutions and their apparent short-comings, Turner et al. [22] wrote that residential lighting could be optimised by time-structured illuminances designed for circadian demands during daytime hours and limited to lower thresholds required for vision during the night. Architectural solutions that can supplement such illuminances and such solutions include the use of skylights, large windows, and passive light pipe illuminators [22]. In addition, Figueiro [34] has proposed a 24-hour lighting scheme for older people. Figueiro's daytime lighting system would provide higher ambient light levels (400 lx at the cornea) and use light sources with more short wavelength content, i.e., 6,500 K or higher. Her evening lighting system would use fewer luminaires to provide lower ambient light levels (<100 lx at the cornea) and use light sources with less short-wavelength content (such as 2,700 K) [34]. In the bedrooms, ceiling luminaires can be used as the daytime system (>6,500 K) and turned off during the evening. Table and floor lamps using 2,700 K compact fluorescent lamps can be used to provide evening ambient illumination [34]. According to Boyce [19], (p.16), the aims of this "scheme are to provide high circadian stimulation during the day and low circadian stimulation during the night, good visual conditions during waking hours and nightlights that are safe for movement but that minimise sleep disruption". In addition, nightlight should provide no more than 5 lx at the cornea and provide residents with perceptual information that enables them to orient themselves around the space [19]. Assuming that specific tasks are to be performed in common rooms, additional illumination is needed to perform (instrumental) activities of daily living as well as for leisure activities.

The implementation of adequate lighting calls for carefully chosen lighting solutions, as was illustrated by Figueiro's [34] lighting scheme. Circadian efficacies of lighting solutions are among the factors that need to be considered. Table 2.6. shows that particularly fluorescent light sources with a high correlated colour temperature yield the highest circadian efficacies, i.e., influence day and night rhythm and possibly behaviour.

Table 2.6. The calculated ratio of circadian to visual efficacies of commercially available light sources; scaled such that the incandescent lamp has a circadian efficacy of 12 CS/W and a luminous efficacy of 12 lm/W). Taken and adapted from Figueiro [34] and Boyce [19].

| (Correlated) colour temperature [K] | Type of light source | Circadian / visual ratio |
|---|---|---|
| 4,100 | Fluorescent | 0.72 |
| 2,700 | Fluorescent | 0.73 |
| n.a. | Incandescent | 1.00 |
| 3,000 | Fluorescent | 1.08 |
| 6,500 | Daylight | 2.07 |
| 8,000 | Fluorescent | 2.11 |
| 7,900 | Metal halide | 2.22 |
| 17,000 | Fluorescent | 3.84 |
| n.a. | Blue LED | 17.6 |

n.a. = not available

In the seven nursing homes, lights were mainly 2,700 and 3,000 K fluorescent light sources, whereas a minimum at 6,500 would be advisable from the perspective of health and well-being (Table 2.6, as the circadian/visual ratio of such light is twice that of 2,700 K light).

In this study, the measured correlated colour temperature differed from one nursing home to the other. The year of construction of the nursing homes, and hence the architecture and choice of building materials, can explain the measured differences in correlated colour temperature. In the newer buildings, common rooms are constructed with a larger window surface area. This results in exposure of residents to higher correlated colour temperatures as they are frequently seated in the window zones. Windows of the common rooms were situated at the 'broad' side of the rooms, i.e., the longest wall of a room is equipped with windows, resulting in more daylight access. In these common rooms, all residents could be seated near the windows. In the older buildings, windows were placed at the 'narrow' side of the room resulting in low illumination levels.

However, some of the nursing homes showed significant differences in correlated colour temperature and measurements were significantly lower as compared to the threshold of 5,000 K. This can negatively affect NIF effects in the residents. Furthermore, extra attention is needed for light conditions in corridors and halls in five of the seven nursing homes. Step changes in the light conditions, particularly illuminance levels, between common rooms and corridors may contribute to an increased risk of falls. However this was not a focus of this study, and is a topic for future research.

As high correlated colour temperature light is found in the window zones of the nursing homes in this study, the use of the window zone spaces by residents should be encouraged by nursing home staff and family carers.
In this study, the Kruithof curve [31] has been used to assess light conditions in nursing homes. As to older people with dementia, unnatural lighting conditions may even lead to certain visuoperceptual errors and problem behaviours [7]. At the same time, high correlated colour temperature lighting, which has been recommended in the aforementioned studies, could negatively influence the atmosphere inside some nursing homes as, within the Dutch context, people prefer lower correlated colour temperature light for reasons of cosiness and ambiance. These cultural differences in preferred ambiance have also been suggested by Boyce [32]. Viénot et al. [38] only partly validated Kruithof's rule that the combination of high correlated colour temperature and low illuminance is perceived as unpleasant. No indication was found that high correlated colour temperature is judged more pleasant than low correlated colour temperature. Low correlated colour temperature conditions were judged the most pleasant at any tested illuminance (150, 300 and 600 lx). This again might support the notions of preferred ambiance as stated by Boyce [32].

### 2.4.4. Correlated colour temperature: interior design and NIF effects

The colour content of a room, including the furniture, may impact the colour properties of the light, both in terms of measurements and perception. The findings in this study suggest that the orange-coloured solar blinds found to be a part of the majority of nursing homes' façades impact the ambiance inside by lowering the correlated colour temperature of the light indoors, i.e., creating a warm ambiance. A related effect has been reported in the literature by Mizokami et al. [39], who found that when the colour inside a miniature test space was orange, people in their study perceived the room as being illuminated by incandescent light sources, even though fluorescent lights with a higher CCT were used in the experiment. The colour of an object is thus not only perceived by its luminance and chromaticity but, more specifically, in relation to the environment in which it is placed [39].
The lower correlated colour temperatures found inside the nursing homes in this study, however, also negatively influence the size of the NIF effects, as is illustrated by Figure 2.3. by Górnicka [30]. According to this figure, low correlated colour temperatures seen inside the nursing homes' common spaces would negatively affect NIF effects in the residents. When comparing the ranges of the correlated colour temperature as measured in the seven nursing homes (minimum 2,000 to 2,700 K; median 3,400 to 4,500 K; and maximum 5,200 to 9,500 K) and given the dim conditions indoors, the NIF effect sizes are rather small or negligible. In contrast, the light conditions found in window zones can

contribute to maximum NIF effect sizes if persons spend sufficient amounts of time in these zones, which, in turn, depends on the illuminance and correlated colour temperature of the light (Figure 2.3.). However, the discussion on the correlated colour temperature of light at day time and preferences of the elderly is still unclear.

### 2.4.5. Benefits of lighting and ethics

Improved lighting conditions may lead to a number of benefits for nursing home residents, relatives, and staff. These benefits include more support in daily life from the environment and a decreased burden of care. Moreover, care professionals may benefit from the lighting equipment themselves because of visual and non-visual effects the systems have on persons with normal vision (Figure 2.3.).

As mentioned before [17,18], an improved light condition undoubtedly has benefits in terms of visual capacities. At the same time, special artificial lighting can never be a substitute for taking older adults outside or for care capacity problems. "Every human being has the right to go outside - not merely for sensory activation - even though there are few (in)formal carers to take residents out for a short walk just to catch some fresh air" [17, p.154]. Turner et al. [22] state that the exposure to sunlight is usually minimal and declines with ageing. Young adults in industrialised countries typically receive only 20 to 120 minutes of daily light exceeding 1,000 lx, whereas older adults receive only one third or up to two thirds as much daily bright light exposures. In older women, these levels are a mere quarter or half of the light exposures of age-matched men [22]. This illustrates the need for both the installation of adequate lighting systems in nursing homes as well as the construction of accessible outdoor areas or the stimulation for older people to spend some time outdoors.

In practice, we see programmes aiming at improving the energy efficiency of lighting systems in Dutch health care facilities. This may not only mean the substitution of incandescent lighting by fluorescent lighting but also a lessening of indoor illuminances, particularly as the main emphasis is on energy consumption, not the well-being of older people and other users of health care facilities. Given the obvious benefits of improved lighting conditions, energy conservation measures need to be monitored closely to see if such measures do not lead to a worsening of lighting conditions.

Figueiro [34] recognises the challenges when implementing special lighting solutions due to the initial costs and energy codes and regulations. In her view, these challenges should not stop designers from building public awareness of how lighting can make an important contribution to the lives of older people. "It is this public awareness that will ultimately promote the changes we need to facilitate the implementation of these lighting solutions in senior facilities. Finally, to be truly successful, it will be necessary to go beyond good intentions and begin to formulate thoughtful, quantitative lighting solutions rather than qualitative solutions (i.e. bright or dim or cool or warm). These quantitative solutions should be based upon basic principles of circadian regulation while at the same time maintaining good vision and safety when the residents are awake and minimising sleep disruption and risk of falls at night [34] pp. 159-160]".

### 2.5. Conclusions and recommendations

In all nursing homes that were assessed, illuminances and correlated colour temperature were both below the threshold levels of 750 lx and 5,000 K, respectively, except for the horizontal illuminances in nursing home 6 and the corridors in nursing home 1. This means that residents are living in rather 'dark' environments. These environments, when considering light conditions, might limit their daily activities and social participation. Therefore, care professionals working in nursing homes should pay attention to the light necessary for conducting certain leisure activities and eating and reading tasks. When needed, facility workers should replace the lighting for one with the proper output in terms of illuminance and correlated colour temperature.

Long-term changes in older buildings can be planned in future renovations. In new building projects, proper arrangements for effective daylight and illuminance can be taken into account.

Measurements in different zones showed that the best place to put a table or seats for older adults is, as expected, near the window. However, in many cases tables were situated in the central or rear zone of the common room. This led to table-level illuminances that in the majority of measurements in the seven nursing homes fell below the threshold of 750 lx. It is, therefore, recommended to put tables as close to the windows as possible, approximately 1-3 metres from the window. The same should be done with chairs in which people sit whilst reading a book. Chairs in the window zone should be placed in such a way that the light falls on the book or magazine that is being read. Care professionals should make sure that residents alternate between lighter and darker corners without taking people out of their preferred seats. This can be done, for instance, by organising leisure activities close to the window. The 'dark corners' of the common room can be designed as a television area during the evening hours. In the daytime, older adults should stay as close (1-3 metres) to the windows as possible, as long as illumination equipment is not sufficient. High correlated colour temperature (> 5,000 K, which can be achieved by a combination of daylight and 6,500 K lighting) of ambient light, in combination with higher illuminances (> 2,500 lx for older adults), may positively affect the biological clock, resulting in better sleep quantity and quality. Care professionals should be aware of the benefits of light and change the seating arrangements of residents during the day in order to expose all of them to sufficient amounts of (day)light. In the end, additional lighting systems may be installed to improve the light conditions inside nursing homes as architectural and organisational solutions may not be sufficient.

When leaving the common room to the entry of the corridors, the measured illumination level fell below the standard of 200 lx resulting in dissimilar lighting conditions (i.e., too large step changes). As adaptation to dark is affected by biological ageing, this can increase the risk of falls. Care professionals should be alert to such step changes in illuminance levels between common rooms and corridors and try to equalise these levels as much as possible by adding light sources. Corridors were all located in the inner part of the buildings, which automatically results in low illuminance levels if electrical lighting systems are not sufficient. Professional carers should be aware of badly illuminated environments where their residents spend the larger part of the day. Moreover, facility workers should receive alerts from professional caregivers to install appropriate and sufficient illumination in corridors. Energy saving actions, such as switching off lights, should be done with great caution as the additional light(ing) may, in fact, be needed by occasional passers-by.

Awareness, of improving the indoor environment of nursing homes among technical professionals, including building services engineers, is as important as having awareness among care professionals. On the one hand, lighting technology and controls must be functional and easy to be used. On the other hand, care professionals should be aware of how to implement and use technology as well as to ask for assistance from professionals from the domain of technology. Furthermore, technical professionals should be aware that current lighting guidelines are not specifically developed for older adults even though standards are applied for nursing home settings. In these settings, special attention should be paid to the fact that older adults need more light than younger persons to perform the same tasks and that adaptation to darker conditions is limited in old age.

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# 3

## Chapter 3 Documentation in client files

**Also published in the Journal of Clinical Nursing**

*Sinoo MM, Kort, HSM, Duijnstee, MSH. (2012) Visual functioning in nursing home residents: information in client records. Journal of Clinical Nursing, 21, 1913-1921.*

**Abstract**

**Aim and objectives.**
The aim of this study is to improve (eye)care in nursing homes by reporting and assessing visual functioning (VF) to enhance professional carers' awareness of visual problems.
**Background.**
Older adults experience visual problems due to biological ageing or eye disease. In the Netherlands, the prevalence of visual impairments is the highest in the subgroup of nursing home residents (41.3%). These impairments influence quality of life in terms of limiting daily activities and participation in social activities. Furthermore, 63% of visual problems are defined as "avoidable blindness". For this reason, screening of VF in the nursing home is of major importance. Moreover, VF should also be taken into account to prevent the incidence of falls.
**Design.**
A field study on recorded information of visual functioning and visual assessment in nursing homes.
**Methods.**
Assessment of VF of 259 residents in nursing homes. Subsequently, recorded information in client files is related to the assessment outcome.
**Results.**
Only in 101 (39%) of the 259 client records, was some information on VF found. Whether or not a prescription for new glasses was handed made no difference in reporting on VF in the client record. In more than half of the cases assessed as "low vision or blindness", no information about VF was found. Furthermore, no information was found in 31% (80/259) in cases of suspected visual problems (referrals). A significant proportion of client records ($p<0.05$) showed no recorded information in cases of referral for further checkup.
**Conclusions.**
In this study, one third of nursing homes residents have visual problems, which need further examination by an ophthalmologist. Problems with VF should be assessed and captured in client records. Awareness of residents' VF is a prerequisite for adapting basic daily care to the resident's needs.

**Key words:** daily care, health care records, low vision, older adults, optometric assessment, senior lodgements

## 3.1. Introduction

In the Netherlands, the highest prevalence (41.3%) of visual impairment is found in the subgroup of residents of nursing homes and care institutions [1]. These impairments are limiting to the daily activities and participation in social activities of older adults. These limitations are described in the model of the International Classification of Functioning, Disability, and Health (ICF) (Figure 3.1.). The model provides an overview of various aspects that are influencing activities and participation of nursing home residents[2].

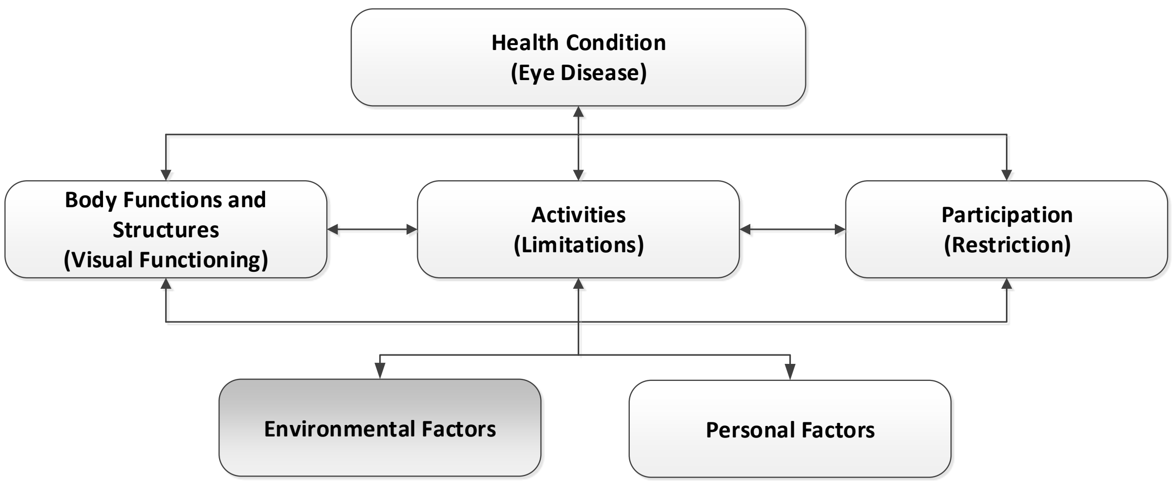


Figure 3.1. The International Classification of Functioning, Disability and Health (ICF) [2].

A health condition can describe such eye diseases as cataracts, glaucoma, macular degeneration, or diabetic retinopathy. Eye diseases will result in the deterioration of visual functioning, referred to as ‘body function and structures’ in the ICF model. Within the ICF, the role of care professionals is seen as an environmental factor. In the case of visual problems, care professionals can influence the clients’ environment and adapt personal care, just as technical staff can adapt a building’s environment and systems. All this will enhance the activity and participation of those residents with low vision or blindness.

There are three main reasons why care professionals in nursing homes should be aware of residents suffering from various kinds of visual impairments [3] and report these problems in client records. First of all, these insights are required to deliver adequate quality of everyday care to the individual resident. Visual comfort and visual functioning must be taken into account when considering activities of daily living, quality of life, and the design of facilities in the nursing home [4,5]. Secondly, if detected, more than half of the cases (63%) in nursing homes suffering from loss of basic visual abilities due to visual

impairments can be treated or prevented from further decline [1]. Third, visual impairment, as well as poor light conditions in nursing homes, can not only result in visual discomfort but are also risk factors for falling [6,7].
Documentation on visual functioning is also necessary for maintenance of continuity of care. For example, in case of absenteeism, the substitute carer should be able to know with a glance at the client record whether a resident is normal sighted or not. Hegde & Rhodes [8] have underpinned the necessity of reporting on visual problems by maintaining that older adults tend not to report on visual problems by themselves.
Nursing documentation reflects residents' needs and must be an instrument to supply all necessary information for care planning. Daily care should include awareness of vision problems as this is a prerequisite for adequate daily care and should be reflected in client records. In case of deterioration of visual functioning, daily care should be adapted. Continuity of care is essential in nursing homes to maintain quality standard in care delivery. Therefore, without adequate documentation the amount of sick leave in nursing homes (5.4%) [9] can be a major threat to the continuity of quality care in the Netherlands. In this study vision problems of older adults in Dutch nursing homes are described in relation to the information gathered in care reports.
The aim of this study is to improve both eye care and daily care for nursing home residents by giving insight into the level of availability of information in client records and to assess whether professional caregivers are aware of this information. This is accomplished by data collection on the diagnosis of visual impairments and visual functioning, which is then compared to what has been registered in client records. This study is intended to enhance the awareness of professional caregivers in nursing homes and is part of a larger project on visual functioning and light conditions in the nursing home.
We focus on the following research questions:
Which problems occur with visual functioning in nursing home residents?
Is visual functioning of nursing home residents recorded in their records?
Is information recorded about the visual functioning of nursing home residents when they have visual problems?

## 3.2. Background

In the Netherlands, 158,000 older adults are institutionalised and living in nursing homes or care homes [10]. A review by Evans & Rowlands (2004) showed that between 20% and 50% of older adults have undetected visual problems. This matches the proportion found in an earlier study in the Netherlands, which showed that 41.3% of older adults lose part or all of their vision due to eye disease or normal ageing [1].

### 3.2.1. Visual problems

As a result of the biological ageing process, the amount of light reaching the retina is reduced with increasing age [11]. A sixty-year old person needs three times the amount of light to perform a task as compared to a twenty-year old [1, 11,13]. Apart from visual problems due to biological ageing, eye diseases, such as cataracts, glaucoma, macular degeneration and diabetic retinopathy, can cause serious vision problems [11,12,14,15]. Limburg & Keunen [1] state that 63% of older adults are estimated to suffer from avoidable blindness due to cataracts, refractive errors, and glaucoma. This proportion of cases of avoidable blindness in nursing homes is partly derived from the total proportion of cataract and refractive errors and partly from half of the proportion of glaucoma and diabetic retinopathy [1]. Cataract and refractive errors are seen as avoidable blindness, while glaucoma and diabetic retinopathy are viewed as avoidable blindness due to prevention in 50% of these cases if diagnosed in time.

Visual impairments can affect several visual functions, such as visual acuity, light-dark adaptation, contrast sensitivity, and loss of visual field. Some older adults are affected by a longer recovery time for the effects of glare resulting from reflected light from shiny objects or bright light directly reaching the eye [16].

Older adults with vision impairments should be detected for ophthalmological referral to prevent further decline in their sight as well as to ensure comfortable living and wellbeing and to decrease the risk of falling. To maintain quality of life of nursing home residents, special attention should be paid to the prevention of falls in older adults. Falling is a major problem for frail, older adults suffering from visual problems [6,17] and care can be adapted to prevent fall incidents. In order to decide for further referral to the ophthalmologist, the battery of testing visual function should contain such relevant tests as visual acuity, intraocular pressure, visual field, and contrast sensitivity [18].

## 3.3. Methods

This study is part of a larger project on visual comfort in nursing homes. The results of the study concerning the light conditions in nursing homes are already published [19]. This study describes visual comfort from the perspective of visual functioning.

### 3.3.1. Study design

In this study, nursing homes in the central region of the Netherlands were enrolled. These nursing home (were willing to improve awareness of professional carers on the visual functioning of the residents. Four nursing home organisations (with seven buildings) showed interest and were included in the study. Out of a total of 686 residents in the four nursing home organisations, a minimal sample size of 242 residents was calculated using power analysis on the basis of a 41% proportion of low vision problems in the Dutch population [1]. (CI 95%, margin 5%).

### 3.3.2. Data collection

The selection of residents was performed on the basis of informed consent and willingness of residents or their family to participate. In the four organisations, 259 residents in total were willing to participate in the project. Data collection took place from February 2009 till August 2010. Possible visual impairments of these 259 older adults were identified by a validated conventional eye assessment conducted by a qualified optometrist of Bartimeus (an organisation in the Netherlands that aims to improve quality of life for the blind and visually impaired by providing personal advice, guidance, and knowledge http://www.bartimeus.nl/english_index). Subsequently, care reports of the participants are complementarily analysed in terms of visual impairments reported by the carers. All 259 records of the participating residents were analysed using a standardised form developed by Bartimeus.

### 3.3.3. Assessment of visual functioning

Within the framework of this study, visual functioning and visual impairments are first assessed by a visual functioning screening. The aim of this screening is to detect a range of visual problems. All examinations were conducted in the nursing homes. According to the definition of ICD 10 of the WHO, normal vision is defined across the two dimensions of vision acuity (> 0.3) or the visual field (> 30°). Best Corrected Visual Acuity (BCVA) was assessed to categorise participating residents in groups of “normal vision” or “low vision or blindness”. The visual field assessment was conducted by a confrontational method and residents were categorised in terms of an “intact visual field” or a “not intact visual field”.
The optometric assessments were conducted according to the standard procedure as developed by Bartimeus. A qualified optometrist and an administrative assistant of this organisation conducted the eye assessments, taking approximately an hour. In preparation for the assessment, the optometrist received medical and ophthalmological information that was recorded from the client records. During the assessment, the assistant administrates the results on the visual functioning tests that were assessed by the optometrist. Accordingly, the assistant completes and checks the form filled out by the researcher on the medical and ophthalmological information from the client records.

The optometric assessment consists of several aspects and was conducted in the same standard order:
1. Examination of spectacles: if necessary a new prescription was handed out and annexed to the visual status report.
2. Defining of residents with low vision (≤ 0.3) according to the WHO ICD 10 definition of visual acuity (BCVA).
3. Observation of visual functioning: visual field confrontation tests, contrast sensitivity, measurement of light sensitivity, intra ocular pressure with an Icare tonometer, and an ophthalmoscopic examination of the interior of the eye.

### 3.3.4. Assessment of client records

An initial screening of the client record was performed by the researcher before the optometric assessment. The purpose of this first screening is to provide the optometrist with information of the residents' status in preparation for the assessment. During the optometric assessment, this first analysis is done by an optometric assistant.

The researcher visited the administration rooms of the nursing homes in order to analyse the client records. Client records were kept in folders for each client in three nursing homes organisations. One nursing home organisation used electronic client records. In all nursing homes, the researcher was free to choose the moment to enter the offices in which records were kept. Screening of the client records is conducted on fixed categories: the number of medical diagnoses, the content of the diagnoses, eye diseases and treatments in the past, the use of spectacles or any information connected to visual problems, and the use of eye medication. These categories are analysed in the same order while the resident participates in the eye assessment.

### 3.3.5. Statistical analysis

Data analysis is carried out using SPSS 18.0 for Windows (SPSS Inc., Chicago IL, USA) with a critical p-value of 0.05. Non-parametric statistics, using the Kruskal-Wallis H-test, were employed to test difference in age groups in the nursing homes. $Chi^2$ was applied to consider relations in cross tabulations of the difference of recorded or unrecorded information when receiving a prescription for new glasses, being diagnosed for "low vision or blindness" or being referred to an ophthalmologist for a further checkup. $Chi^2$ was carried out if more than 75% of the cells had an expected value of 5 or more.

### 3.3.6. Ethical approval

In the Netherlands, this type of research on standard care is not covered for review by the Medical Research Involving Human Subjects Act (http://www.ccmo-online.nl).
All residents were selected by willingness to participate in the study with informed consent. In all participating organisations, policy was an information procedure by a letter sent to the residents or the family carers in which the visual assessment was explained and permission for analysis of the participants' record was explicitly formulated. In three of the nursing homes, it is a policy to always inform client boards explicitly about new research projects. As a special point of interest, it was mentioned that all results would be discussed with the participating residents or their family and a prescription for a new pair of spectacles would be dispensed if needed.
The residents or the family of residents signed an informed consent letter to participate in the study. Due to cognitive problems, some residents were not able to decide on participation. In those cases, the family decided after communication with the resident. In the letter, the procedure of the study was explained and explicit approval was asked for the screening of client records. Residents or family carers received the letter of informed consent from the ward they were residing in. In this study, all participating residents or their families gave approval to participate.

## 3.4. Results

The number of participating residents was 259. The mean age of the 259 participating residents in the four organisations was 81.3. No statistical difference in age was found between the four participating nursing homes organisations ($Chi^2 = 1.324$, $df = 3$, $p = 0.723$), which is a reflection of the population of Dutch nursing homes according to age, sex, and psychogeriatric or somatic syndrome.
Of the 259 participating residents, 163 (63%) were residing in psycho geriatric wards and 96 (37%) were residing in rehabilitation or somatic wards. In the Dutch population, the ratio of residents residing in psycho geriatric and somatic wards is 1:1 [20], whereas in this study, the ratio is approximately 2:1.

### 3.4.1. Information recorded in client files

The contents of all 259 client records were assessed on information in relation to visual functioning. In 101 (39%) of the 259 client records, some information was found.

#### 3.4.1.1. Information recorded about the glasses of the participating residents

The first part of the visual assessment of 259 residents was to check whether residents had the correct pair of spectacles needed for their eyes. Furthermore, a prescription (for a new pair) was prescribed if needed. As can be seen in Table 3.1., most participating residents (215 = 83%) did not need a prescription for a new pair of spectacles. Of the 44 (17%) residents who did receive a new prescription, no information on visual problems was found in the client records in 27 out of these 44 cases (61%). No significant difference was found in the number of residents receiving a prescription or not in relation to the recording of information in the care reports ($Chi^2 = 0.003$, df = 1, p = 0.957).

Table 3.1. Cross tabulation of the number of residents receiving a prescription for a new pair of spectacles and information found in the client records.

| | Spectacles | | |
|---|---|---|---|
| | Prescription | No prescription | Total |
| No information on visual problems in client record | 27 | 131 | 158 |
| Information on visual problems in client record | 17 | 84 | 101 |
| Total | 44 | 215 | 259 |

#### 3.4.1.2. Information recorded about low vision

For 13 of the 259 participating residents, an assessment of visual acuity was not possible due to poor physical alertness. In Table 3.2., a cross tabulation of visual acuity outcomes in relation to recorded information is shown. The 246 assessed residents are grouped in two categories of “normal vision” (182 = 74%) or “low vision or blindness” (64 = 26%). In more than half of the cases assessed as “low vision or blindness”, no information at all on visual problems was found in the client records (35 out of 64 = 55%). No significant difference was found between information in client records when residents had normal vision as compared to residents with low vision or blindness ($Chi^2 = 1.253$, df =1, p = 0.263).

Table 3.2. Cross tabulation of assessed residents with normal vision and low vision, or blindness and information found in the client records.

| | Low vision | | |
|---|---|---|---|
| | Low vision/blindness | Normal vision | Total |
| No information on visual problems in client record | 35 | 114 | 149 |
| Information on visual problems in client record | 29 | 68 | 97 |
| Total | 64 | 182 | 246 |

#### 3.4.1.3. Referral for further check up

In Table 3.3., the results are shown of the total of 259 participating residents. One hundred nineteen (46%) were advised to visit an ophthalmologist for further checkups or to consult a rehabilitation centre. In a significant number of cases referred for further checkups ($Chi^2 = 4.204$, $df = 1$, $p = 0.04$), no information on visual problems was found in the client records (80 out of 119 = 67%).

Table 3.3. Cross tabulation of residents referred to an ophthalmologist for checkups or to a centre and information found in the client records for rehabilitation.

| | Advice | | |
|---|---|---|---|
| | Referral | No referral | Total |
| No information on visual problems in client record | 80 | 78 | 158 |
| Information on visual problems in client record | 39 | 62 | 101 |
| Total | 119 | 140 | 259 |

Relatively more client records (80 out of 119) of referred residents had no information at all as compared to the non-referred residents (78 out of 140).

## 3.5. Discussion

In this study, the proportion of participating women (78%) was slightly higher than that in the Dutch population of elderly care facilities (77%) [21]. The mean age of the 259 participating residents in the four organisations was slightly lower in this study (81.3) compared to 84.3 the wider population [20].

### 3.5.1. Information recorded in client files: prescription of new glasses

In this study, the results show that no special attention is being paid to vision problems in the nursing homes. This confirms the emphasis of several studies on screening of older adults in nursing homes [16, 22-24] and on environmental factors supporting the vision of nursing home residents [5, 8, 11,13,19, 25]. In the case of prescriptions for new glasses, no statistical difference was found in the proportion of prescriptions and reporting in the client files. All residents appeared at the assessment with their own pair of spectacles, and no cases were observed in which residents wore spectacles of others from the ward. However, no special attention was paid to the relationship of wearing spectacles and visual functioning. Therefore, it made no difference in reporting whether or not a prescription for new spectacles was given. The same result was found in cases of low vision/blindness and normal vision.

The development and specialisation of eye care may indicate the failure of nurses to implement their duty in this area of care. Moreover, they might also see the purchase of glasses as an accessory like purchasing an article of clothing.
Professional caregivers in the nursing home should be more attentive to visual functioning in relation to glasses and ask about and report the quality of how residents function with their glasses. In the Netherlands, it is uncommon for an optician to visit nursing homes on a regular basis. Service by an optician could, therefore, be a solution for providing the right pair of spectacles and for assuring that it is recorded in client files. Nevertheless, professional carers still have the responsibility to report cases if they doubt the lack of visual functioning in relation to the use of glasses.

### 3.5.2. Information recorded in client files: low vision

In cases of low vision/blindness or normal vision again, no special attention was paid to reporting. Knowledge about the visual problems of the residents is required to adapt to their needs. To enhance the awareness of carers, the elderly care physician of the ward can take a first step of assessment in this process.
In this study, as a result of the assessment, the elderly care physician of the ward was handed a report of the visual status of the participating resident, and the report was appended to the client record. In this way, the possibility was created to enhance the knowledge of professional carers about visual functioning. This report could be discussed in multidisciplinary teams of all persons involved, including residents and their family carers. The elderly care physician of the ward can cooperate with an optometrist for further assessment if low vision is suspected.
Reporting in records about normal as well as low vision or blindness is important. Hence, if a resident is normal sighted, this should also be reported. In this study of the 246 assessed residents, 26% were categorized with low vision or blindness. This is a lower proportion as compared to the estimation of 41.3% in the study [1] . In our study, low vision or blindness was registered according to the Best Corrected Visual Acuity (BCVA). The visual field was assessed by a confrontational method, but not used in the categorization of vision. However, if the visual field was incorporated in the categorization, the proportion of assessed residents with low vision or blindness would have been higher.

### 3.5.3. Information recorded in client files: referral for further check-ups

No information at all was documented in a statistical higher proportion of referred residents as compared to those residents not referred. Special attention should be paid to this group by screening for eye diseases in order to retain quality of life [26] and, in addition, because of a higher risk of falls and low vision or blindness.

The role of professional carers is seen as an environmental factor in the ICF-model. In a Cochrane review of five studies, Smeeth and Iliffe [27] concluded that after assessment of visual problems, an intervention plan is needed. Adequate recording of these problems in client files can be a first step in this process. In Dutch nursing homes, professional carers are working in multidisciplinary teams and report on care and treatment approaches in the client file. Care problems are formulated in a process of reflection in these teams. Professional carers can discuss observations on residents and report, for instance, on vision problems if observed. If necessary, the problem is defined and described in the client file resulting in a plan for action.

Older adults do not tend to report on visual problems by themselves [8]. To be more effective in dealing with these problems, professional carers should be educated to distinguish between different aspects of visual functioning, such as visual field loss, decrease of visual acuity, or blurred vision. Adequate care delivery to older adults with low vision should be part of the job of professional caregivers in the nursing home.

Although screening for visual functioning with a large battery of tests will increase costs, such screening of residents suffering from avoidable blindness due to cataracts (55%) and those with high intra ocular pressure (IOP) suspected of glaucoma (8%) can be prevented from becoming blind [1]. This does not only guarantee a better quality of life for the persons involved, but in the long run such an investment has an economic payback as well. The more dependent patients become, the more care investment is needed. Screening of visual functioning can be performed by the elderly care physician. The optometrist can perform a supplementary screening for those residents suspected of eye pathology. Screening of visual problems is necessary to prevent further health deterioration. Therefore, special attention is needed in the educational program for nursing home physicians as well as optometrists for screening nursing home residents.

#### 3.5.4. The role of professional caregivers in visual functioning

The impact of vision problems in older adults should affect daily institutional care [28] in creating a healthy environment for older persons with low vision. Professional carers can improve the quality of life of the nursing home resident by delivering adequate care [29] and by retrofitting the environment. This will stimulate the activity and participation of residents as formulated in the ICF model [2] .

Professional carers should be aware of lighting in the nursing home according to quality of illumination [30, 31]. For example, older adults need more light than younger people and will need to be seated at the window side of the common room [19]. Carers can stimulate residents to alternate between lighter and darker corners without taking people out of their preferred seats. This can be done by organising leisure activities close to the window. The 'dark corners' of the living room can be designed as a television area during the evening hours. When illumination equipment is not sufficient, older adults should stay as close to the windows as possible during daytime [19].

Small changes in daily care can be of great importance for the visual impaired. However assessment [26] and documentation of vision problems is an important step in the improvement of quality of life.

### 3.6. Conclusions

One third of nursing homes residents have visual problems which need further examination by an ophthalmologist. These visual problems are, however, not recorded in client records. No significant difference was found in whether or not information was recorded when residents had normal vision as compared to residents with low vision or blindness. Therefore, for the caregiver, it will not be clear whether "no information" means that a resident is normal sighted. Especially in those cases with referral for further checkup, the lack of information was evident and could be improved.

Attention for improvement should be paid to visual functioning rather than to the glasses that residents wear. Visual impairment should be reported in the client file in order to be able to retrofit the environment and adapt to daily care. Visual functioning of nursing home residents should be assessed and captured in client records to avoid the possibility of the residents developing correctable blindness. In addition, insight into visual impairments opens opportunities for professional carers to improve the environment and prevent residents from falling and succumbing to further health decline. Therefore, awareness of residents' visual impairments and insight into consequences for daily functioning is important for the alignment of basic daily care of the individual resident.

### 3.6.1. Relevance to clinical practice

Problems with visual functioning and vision impairments should be assessed in the nursing home for residents to avoid the affliction of correctable blindness. In addition, insight and awareness into visual problems opens opportunities for professional carers to develop and apply interventions for environmental adaptations and prevent residents from falling.
Awareness of residents' visual functioning and their visual impairments, which have consequences for their daily activities or social participation, will also support care professionals in their possibilities to adapt basic daily care to the residents' needs .

**Contributions**

Study design: MS, HK; data collection and analysis: MS, HK; manuscript preparation: MS, HK, MD.

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# 4

## Chapter 4 Visual Pathologies, Light Conditions and Recording in Client Files

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*Sinoo MM, van Tilborg M, Schols JMGA, Kort HSM. (2014) Age Related Visual Pathologies among Nursing Home Residents: An Evaluation of Light Conditions and Recording in Client Files. World Journal of Social Science Research, 1 (2), 136-150.*

**Abstract**

**Objective:** Reflection on visual problems in nursing homes.
**Data Sources:** Eye examinations, documented visual problems and illuminance levels.
**Study design:** The optometric examinations and recorded visual problems were combined with illuminance data.
**Data collection:** In seven nursing homes, 259 residents underwent an optometric examination. Their client records were analysed for information regarding visual functioning. The illuminance data were ranked to set the quality of the lighting conditions.
Principal findings: 50% of the referred residents had problems with cataracts, retinal problems (21%), suspected glaucoma (13%), and other pathologies (16%). The information was not current in 56% of the records. The quality of lighting conditions was low or moderate.
**Conclusion:** The finding of poor lighting conditions in nursing homes in combination with a high prevalence of visual problems (with cataract found to be the most common age related pathology), stresses the need of enhanced awareness of eye care by professional caregivers.

## 4.1. Introduction

The prevalence of visual impairment is high in people aged 50 years and older according to the "global data on visual impairment 2010" published by the World Health Organization [1]. The WHO report states that, 65% of visually impaired people and 82% of all blind people are 50 years of age and older. Global data from the WHO [2] also show that the main causes of visual impairment are uncorrected refractive errors and ophthalmological disorders: age-related macular degeneration, cataracts, glaucoma, and diabetic retinopathy. Eye pathologies cause a loss of basic visual abilities and visual functioning, such as visual acuity, contrast sensitivity, dark adaptation, and visual field loss [3]. The highest estimated prevalence (> 40%) of visual impairment (blindness and low vision) in the Netherlands has been found in the subgroup of residents of nursing homes and residential care facilities [4]. A study by Wang et al., [5] suggested a higher incidence of nursing home admissions among visually impaired older adults. The environmental design of nursing homes is an influential factor when considering daily activities and quality of care [6-9].

In the Netherlands, a broad range of care professionals is employed in nursing homes, including the nursing care coordinators and caregivers, and medical staff (nursing home physicians) as well as the paramedical and psychosocial staff [10]. A nursing home physician is responsible for both delivering medical care and directing the complex care processes of residents and can be supported by a geriatric nurse practitioner [11] . Following a multidisciplinary approach, the care requirements of the residents are assessed in close cooperation with the patients and their families. In addition to the regular multidisciplinary team, the nursing home physician can consult external specialists, such as an ophthalmologist, optometrist, low-vision organization, or so-called "flexible eye bus" (described below), in cases of suspected eye problems.

In the Netherlands, two umbrella organizations for low vision care, Bartimeus and Visio, are generally asked to perform optometric examinations in nursing homes. Bartimeus, an organization that aims to improve the quality of life for the blind and visually impaired [12], participated in the eye examinations in this study. In 2008, the "flexible eye bus" was created in the Netherlands by the Rotterdam Eye Hospital [13]. This bus parks in the neighbourhoods of nursing homes or senior housing centres and offers eye screenings on demand. Nurses or family members take residents to this bus. Throughout the Netherlands, optometrists may visit nursing homes, but only on demand of resident, their family or professional caregivers.

#### 4.1.1. Application of the ICF framework

The role of care professionals and the environment of the nursing home can be described by the framework of the International Classification of Functioning, Disability, and Health (ICF), published by the WHO [14]. The ICF framework originates from the emancipation movement for disabled persons and provides a multi-perspective approach to classifying the functioning and disabilities of individuals with chronic or disabling conditions. This framework is also applicable to older adults with impaired vision. In general, the ICF is used to describe and measure health and disability, and it acknowledges that every person may experience some degree of disability due to a deteriorating health status. The ICF focuses on the impact of health status decrements, and disability is not only described as a medical "dysfunction." The impact of the environment is also addressed by including contextual factors [14]. The ICF lists various related components, including health conditions (disorders or diseases), bodily function and structures, activities and participation, and environmental and personal factors. Figure 4.1. shows that the framework of the ICF provides a description of domains that are related to eye diseases. The interaction of these components in an individual with an eye disease is also shown in Figure 4.1. Personal factors are not considered in this study. This study puts an emphasis on the nursing home environment.

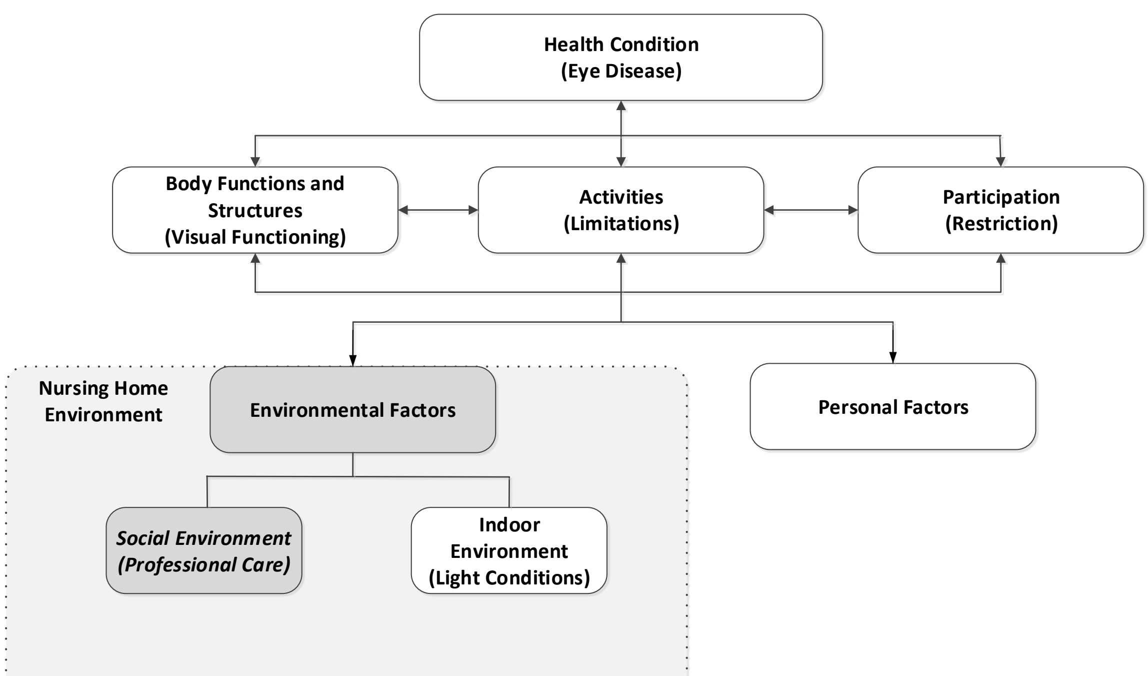


Figure 4.1. Interactions between the ICF components for nursing home residents, based on the ICF model [14].

The factors for persons with eye diseases or disorders in the ICF environmental component can be divided into the social environment (professional caregiver tasks related to visual problems) and the indoor environment (light conditions). Therefore, the nursing home environment is an influential factor when considering the daily living activities of residents with visual problems.

In nursing homes, all-care professionals are considered to be part of the social environment for persons with visual problems. These professionals should be aware of the indoor environment as well as the potential visual problems of the residents. Moreover, the ICF invites care professionals to communicate regarding the functioning of their clients in a "common language" [14]. Potential changes in the indoor environment (building aspects), which can be made for residents with eye problems include improving lighting conditions by controlling the illuminance levels. The majority of older adults require more light than younger people and should therefore be seated in positions with access to appropriate lighting conditions ([15-17]. This may be near a window or in a properly illuminated place when the resident is performing a task. Furthermore, uniform illumination is advised because adaptation to the dark can be impaired in older adults [16]. The benefits of sufficient light levels inside nursing homes are not only "image-forming" (i.e., to improve sight) but they also play a role in regulating important biochemical processes, such as immunologic mechanisms, circadian rhythm, and behaviour [18,19].

This study considers the inclusion or lack of the sensory perceptual needs of residents in the client records of nursing homes. The researchers discuss this from the perspective of environmental factors, health conditions (eye disease) and visual functioning set forth in the WHO ICF framework. In addition, a reflection is made on the role of professional caregivers.

The following research questions were formulated:

1) What is the quality of the illuminance levels in common rooms and corridors in nursing homes?

2) What age-related eye pathologies do optometrists report after eye examinations?

3) What is the status of recording of information on visual problems or other eye-related data in client files?

## 4.2. Methodology

The total study consists of three parts. In the first study [15] lighting conditions were discussed. Illuminance levels and correlated colour temperature were assessed in seven nursing home buildings. The main finding was that at least 55 % of the illuminance measurements fell below the threshold of 750 lx. In this first study no information about client records was given. The second study [6] addressed the recording of general eye care

information in client records in the seven nursing homes. The findings of this second study showed that a significant proportion of client records showed no recorded information on visual functioning (the use of spectacles; normal vision, low vision or blindness).
In the present study unused data from the second part of the study on age-related eye pathologies among the nursing home residents are combined with the data from the first part of the study on lighting conditions.
Four different nursing home organizations (with seven nursing home buildings) in the central region of the Netherlands participated in both previous studies [6,15]. These organizations were motivated to improve the awareness of adequate eye care among their caregivers. In an introduction to all 4 organizations, the boards of the organizations' management and their client councils were asked to participate in the study. Optometrists from Bartimeus performed the eye examinations in the same order and acted independently in this study. A few months after the data collection, Bartimeus offered low vision support to the nursing homes.
Data analysis was carried out using SPSS 20 for Windows (SPSS Inc. Chicago, USA) with a critical p-value of 0.05. Non-parametric statistics, using the Kruskal-Wallis H-test, were employed to test differences between age groups in the nursing homes.

### 4.2.1. Selection of Residents and ethical considerations

Among the 4 organizations, 259 out of 686 residents and/or their legal representatives agreed to participate. Families and caregivers decided whether the residents were capable of participating in the eye examination. The selection of residents was based on informed consent and the willingness of the residents and/or their legal representatives to participate voluntarily in a single optometric eye examination. Signatures for consent were collected via paper forms.
The letters asking for informed consent included two choices:
1) A consent form for participation
2) A form expressing the desire to not participate
A resident began participation in the study if informed consent was received. If the paper was not returned, no action on participation was taken. The non-response was not considered in this study and no further action was taken on this. One reason not to participate was for instance the estimation of the family that participation would be too much a burden for the resident.

### 4.2.2. Measurements

#### 4.2.2.1. Assessment of visual impairments

Single eye examinations were performed, which included refraction, assessment of the anterior and posterior segments of the eyes, bio-microscopy (slit-lamp examination), ophthalmoscopy, and intraocular pressure (IOP) measurements. Additionally, neurologic tests, such as light sensitivity, pupil reaction, visual field assessments (confrontation method), and contrast sensitivity measurements (by a low-contrast vision test), were performed. The eye assessment was summarized in a report that was intended for the ward (care coordinator and nursing home physician). In this report, the optometrist also indicated whether a referral for further examination by an ophthalmologist would be necessary. The optometric examination of age-related pathology lasted for approximately one hour per resident, and an optometric assistant recorded the data.

In the Netherlands, this type of research on standard care delivered by Bartimeus does not require review by the Medical Research Involving Human Subjects Act (http://www.ccmo-online.nl). Nevertheless, data were collected and treated according to The Dutch Data Protection Act (htpp://www.dutchdpa.nl).

#### 4.2.2.2. Measurement of illuminance levels

As described in Sinoo et al. 2011 [15] measurement of the illuminance levels was performed using a Konica Minolta cl-200-A Chroma meter (by Konica Minolta Sensing Americas Inc.) to assess the lighting conditions in the seven nursing homes. The measurements (E [lx]) were performed in locations where the residents spent most of their time during the day (common rooms and corridors).

All light measurements were performed during the day between 10:00 AM and 3:00 PM from October 2009 to March 2010. The measurements included the contribution of daylight and reflected the light situation as encountered at the moment of observation. The light sensor was held in a vertical position, mimicking the central gaze line ($E_v$), at a height of 1.6 m. The light sensor was laid in a horizontal orientation at table level, a height of 0.9 m, and at chair level of 0.6 m ($E_h$). These heights represent older adults (male and female) standing upright as they walk around common rooms and corridors (1.6 m), perform tasks while seated at a table (0.9 m), or hold items in their laps (0.6 m), respectively. This resulted in two types of measurements in common rooms:

1) $E_v$, representing residents walking around or standing upright in common rooms

2) $E_h$, representing residents performing a task either at table level (0.9) or chair level (0.6). These are not separated in the data analysis.

In corridors, one measurement ($E_v$) was used, representing people walking around or standing upright.

In appendix 1 the time schedule of the data collection in the four nursing home organisations is shown.

### 4.2.3. Data analysis

#### 4.2.3.1. Information in client records

As described in Sinoo et al. 2012 [6], the screening of the client records was performed by the researcher a few days before the optometric examinations took place. During the optometric examination of the resident, the optometric assistant completed, if needed, the information found by the researcher. The researcher visited the administration rooms of the nursing homes to analyse the client records, and during the optometric examination the client record of the resident was taken with him. Client records were kept in folders for each client in three of the four nursing home organizations. One nursing home used electronic client records. In all nursing homes, the researcher was free to enter the offices in which records were kept. Screening of the client records was conducted using fixed categories: the diagnoses of eye diseases, past treatments, use of spectacles or any information connected to visual problems and use of eye medications. Furthermore the information was categorized as current or past visual function information, such as:

1) For past information: eye surgeries or eye problems in the past

2) For current information: the use of spectacles and current eye medications, eye diseases or visual field losses.

Past information is seen as information prior to the admittance to the nursing home.

#### 4.2.3.2. Quality of light conditions

As described in Sinoo et al. [15] the observed illumination levels were compared with the average acceptable threshold values of 750 lx (common rooms) and 200 lx (corridors). These threshold values were based on The Dutch Society for Illumination guidelines [20] (Stoer, 2006) and the values stated by van Hoof & Schoutens [21] and De Lepeleire et al. [22]. The latter authors recommend adjusting the threshold levels of the originally stated 500 lx for offices to 750 lx or even to 1,000 lx for older adults.

Categorization of the buildings according to lighting conditions was performed by ranking the measured illumination levels into “Good”, “Moderate” or “Low” quality. If <10% of all measurements in the common spaces and corridors were below the threshold level of 750 lx, the building was considered to have good quality lighting conditions. If 11% to 66% of all measurements in the common spaces and corridors were below the threshold level of 750 lx, the building was considered to have moderate lighting conditions. If >66% of the measurements in the common spaces ($E_v$, $E_h$) and corridors ($E_v$) were below the threshold level of 750 lx, the building was considered to have low quality lighting conditions.

## 4.3. Results

The results are described in the following order: first, the lighting conditions in the participating nursing homes are described, followed by the characteristics of the participating residents, their reported referrals by the optometrist, and the information found in their client records.

### 4.3.1. Light conditions in the nursing homes

The ranking of the lighting conditions in the seven nursing homes is presented in Table 4.1. The ranking is based on the percentage of measurements below the threshold in common rooms ($E_v$ and $E_h$) and corridors ($E_v$).

Table 4.1. Ranking of the quality of light conditions in the seven nursing homes, based on the study by Sinoo et al. [15].

| Nursing home Building | Number of common rooms measured (N = 59) | Ev in the eye-gaze direction, common spaces | | | | Eh at table height or lap level, common spaces | | | | Ev in corridors | | | | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Emin [lx] | Emax [lx] | N < 750 lx | % Below thres hold | Emin [lx] | Emax [lx] | N < 750 lx | % Below thres hold | Emin [lx] | Emax [lx] | N < 200 lx | % Below thres hold | Quality of light conditions |
| 1 | 2 | 110 | 850 | 13/14 | 93% | 290 | 460 | 5/5 | 100% | 20 | 250 | 9/12 | 75% | Low |
| 2 | 10 | 30 | 2750 | 88/94 | 94% | 60 | 2500 | 28/32 | 88% | 6 | 240 | 13/14 | 93% | Low |
| 3 | 8 | 90 | 3060 | 59/90 | 66% | 200 | 1880 | 28/41 | 68% | 9 | 260 | 16/21 | 76% | Low |
| 4 | 16 | 20 | 1590 | 170/179 | 95% | 20 | 3670 | 40/50 | 80% | 13 | 250 | 87/89 | 98% | Low |
| 5 | 6 | 40 | 1230 | 77/81 | 95% | 50 | 3330 | 40/43 | 93% | 38 | 2450 | 47/61 | 77% | Low |
| 6 | 12 | 150 | 3700 | 78/120 | 65% | 170 | 3200 | 21/38 | 55% | 14 | 1120 | 15/45 | 33% | Moderate |
| 7 | 5 | 70 | 1770 | 41/54 | 76% | 100 | 3660 | 19/26 | 73% | 18 | 740 | 19/21 | 91% | Low |
| Total | 59 | | | 632 | | | | 235 | | | | 263 | | |

Illuminance levels in common spaces (minimum and maximum levels) compared to a threshold level of 750 lx (frequency of measurements below the threshold with respect to the total number of measurements) and illuminance levels in corridors compared to a threshold level of 200 lx. $E_v$= vertical illuminance, $E_h$ = horizontal illuminance, lx = lux (unit of illuminance). Emin= Minimum illuminance value, Emax = Maximum illuminance value

The residents of all buildings (with or without eye pathologies) lived in an environment with low or moderate quality lighting conditions.
Only nursing home 6 was ranked as having “moderate quality“ lighting conditions. Less than 66%, albeit 65% ($E_v$) and 55% ($E_h$), of the measurements in the common spaces and 33% of the measurements in the corridors ($E_v$) of nursing home 6 were below the threshold.

### 4.3.2. Demographics of the participating residents

The mean age of the 259 participating residents in the four organizations was 81.3 years (± 10.5). No significant difference in the ages of residents was found between the four participating nursing homes organizations ($Chi^2 = 1.324$, df = 3, p = 0.723).
Of the 259 participating residents, 163 (63%) lived in psychogeriatric wards and 96 (37%) lived in rehabilitation or somatic wards. This is a ratio of approximately 2:1. According to the current knowledge of the Dutch nursing home population, the ratio of residents residing in psychogeriatric and somatic wards is 1:1 [23] . According to the WHO criteria for vision impairment, 74% of the assessed residents had “normal vision” and 26% were assessed as having “low vision or blindness” [6].

### 4.3.3. Reason for Reported Referrals (R RR) to the ophthalmologist after optometric examination

In Table 4.2., the reasons for the reported referrals (R RR) by the optometrist are presented along with the quality of the lighting conditions from Table 4.1. and the presence of visual functioning information in the client records.

Table 4.2. Information in client records, quality of light conditions, and reasons for reported referral (R RR) after optometric examination

| | Nursing Home Building | | | | | | | Total N | No info about visual functioning in client record | Info about visual functioning in client record |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| | Light conditions | | | | | | | | | |
| R RR* | Low | Low | Low | Low | Low | Mod | Low | | | |
| Cataract | 5 | 16 | 15 | 9 | 3 | 6 | 5 | 59 | 41 | 18 |
| Glaucoma | 0 | 4 | 3 | 6 | 2 | 1 | 0 | 16 | 9 | 7 |
| Retinal problems | 2 | 3 | 9 | 3 | 7 | 0 | 1 | 25 | 20 | 5 |
| Other | 3 | 8 | 6 | 0 | 1 | 0 | 1 | 19 | 10 | 9 |
| Subtotal | 10 | 31 | 33 | 18 | 13 | 7 | 7 | 119 | 80 | 39 |
| No RR ** | 8 | 8 | 17 | 46 | 27 | 29 | 5 | 140 | 78 | 62 |
| Total | 18 | 39 | 50 | 64 | 40 | 36 | 12 | 259 | 158 | 101 |

* R RR = Reason for Reported Referral to the ophthalmologist after optometric examination by the optometrist;
** No RR = No Reported Referral to the ophthalmologist after optometric examination by the optometrist

After the optometric eye examinations of the 259 residents, the optometrist did not recommend further examination by an ophthalmologist for 140 residents. In these 140 residents, no eye pathology was discovered, the residents had a known eye disease, or they were already under the care of an ophthalmologist or low vision centre. Nevertheless, the optometrist recommended that 119 residents receive an additional ophthalmologic consultation because eye pathology was suspected or detected. In 50% (59/119) of the referred residents, the main reason for referral was related to problems with cataracts, followed by retinal problems (25/119 or 21%), suspected glaucoma (16/119 or 13%), or other pathologies (19/119 or 16%).

Of the 259 client files, 158 files contained no information on visual functioning, and 101 files contained some information, such as the use of eyeglasses, visual acuity, use of eye medications, or known eye pathologies.
Furthermore, the results in Table 4.2. show that 80 of the 119 residents (67%) referred for additional examination by an ophthalmologist had no information on visual functioning in their client records; this finding was observed in 41/59 (70%) of the cataract referrals, 9/16 (56%) of the glaucoma referrals, and 20/25 (76%) of the retinal problem referrals. Similar results were found for individuals with other reasons for referral.

### 4.3.4. Status of information in the client records

The type of information recorded in the clients' files was analysed with respect to current and past data (Table 4.3.). This analysis was performed for all client files (n = 101) with information on visual functioning.

Table 4.3. Cross tabulation of the information related to visual impairments and Visual Functioning (VF) found in client records and their Reported Reason for Referral (R RR)

| | Reason for Reported Referral R RR* | | | | No RR** | Total |
|---|---|---|---|---|---|---|
| | Cataract | Glaucoma | Retinal | Other | | |
| Type of information | | | | | | |
| Wearing eyeglasses | - | - | - | - | 4 | 4 |
| Visual acuity | 1 | - | - | - | 4 | 5 |
| Eye medication | 2 | 1 | - | 1 | 2 | 6 |
| Eye disease | 3 | 1 | 2 | 3 | 20 | 29 |
| Subtotal | 6 | 2 | 2 | 4 | 30 | 44 |
| Past information on VF*** | 12 | 5 | 3 | 5 | 32 | 57 |
| Subtotal | 18 | 7 | 5 | 9 | | |
| Total | 39 | | | | 62 | 101 |

*R RR = Reason for Reported Referral to the ophthalmologist after optometric examination by the optometrist;
**No RR = No Reported Referral to the ophthalmologist after optometric examination by the optometrist
***VF = Visual Functioning

Table 4.3. shows the type of information that was recorded in the 101 client files (of which 39 residents were referred and 62 residents were not referred for ophthalmological examination). The type of information is combined with the reason for referral mentioned in the optometrist's report.

In 57 of the 101 files (56%), the recorded information was related to past events and did not include current information on visual functioning. For 12 of the 18 residents referred for cataracts, the recorded information involved problems from the past, such as bacterial conjunctivitis.

The use of eyeglasses was not recorded for the 39 referred residents (18 for cataracts, 7 for glaucoma, 5 for retinal problems, and 9 for other pathologies) but was recorded 4 times for the non-referred residents.

Visual acuity was recorded in 1 client file for a resident referred for cataracts and 4 times for the non-referred residents. In a few cases (2 for cataracts, 1 for glaucoma, and 1 for other pathologies), an eye medication was recorded in the client files. Similar results were found for the recorded eye diseases.

The optometrist did not refer 62 of the 101 residents for an ophthalmologic consultation. In these residents, some vision-related information was recorded in their files. In 32 of these 62 cases, the recorded information was related to past events and did not include current information. In 30 client files of the non-referred residents, information was found but no progression of the known disease was noted or these residents were already receiving ophthalmological care or were in a known rehabilitation program.

## 4.4. Discussion

Visual impairments and poor light conditions in nursing homes are risk factors for falling [24]. Thus, the environment can hinder older adults suffering from an eye disease or visual impairment [25]. In contrast to this, a nursing home environment with adequate light conditions that have a positive effect on the circadian rhythm may facilitate nursing home residents in their daily activities [16,17].

As shown in Sinoo et al. 2011[15], two buildings (building 6 and 7 in table 4.1.) were both constructed in 2008 and had moderate (building 6) and low (building 7) light qualities. Another building (building 5) was constructed in 1977 and renovated in 2009, but had still low light quality. Hence year of construction or renovation of the nursing homes did not influence the quality of the light conditions.

Of almost two-thirds of all participating residents (158 out of 259), no information on visual problems was present. Nevertheless in more than half of the client records the recorded information was related to past events.

Participation of nursing home residents and their reduced daily activities can be improved when nursing home physicians, geriatric nurse practitioners and nurses have more knowledge about, and insight into age-related eye pathologies of their residents. One prerequisite for this is that the charting of relevant information in the client records is accurate. Another requirement is that nursing home physicians, geriatric nurse practitioners and nurses have a greater understanding and awareness of the quality of light conditions offered to the residents [18]. A recent study by Aarts et al. [26] also showed that the majority of care professionals were not aware of the reasons why a new lighting system was installed on their work floor. Awareness of light conditions is important not only in relation to the quality of illumination, but also in relation to the use of colours and contrasts [27]. The most frequent eye pathology found in this study was cataract or related to cataract. Blurred vision and faded colour (blue and purple), caused by the yellowing of the lens are the main complaints of people suffering from cataract. The use of colours and specifically attention towards contrasts contributes to ease finding the location of doors, furniture and light switches. Furthermore reducing environmental hazards are recommended to prevent the incidence of falls [28,29].
Visual problems differ among individuals and therefore demand specific lighting solutions to support individual nursing home residents in their daily activities. Selecting the appropriate environment and light conditions for all residents can be a complex task because of these individual differences [30]. For example, bright light might be a problem for one resident, whereas another resident might require more light [30-32]. A study by Lindner et al. [33] on the subjective lighting needs of people with cataracts and glaucoma showed the impact of these eye diseases on preferred illuminance levels. For instance, their preferences could be hundreds of lux-units lower than those preferred by healthy subjects. Personalized impaired vision care is not addressed further in this study. However, there should be a greater awareness of residents' vision problems to enable personalized eye care.

#### 4.4.1. Limitations of the study

Bias in scientific research can occur in a variety of ways [34] . In this study, the nursing homes were not chosen randomly. Selection bias may have occurred by purposely sampling four nursing homes that were willing to improve eye care. However, all organizations were functioning under a different umbrella, which creates some diversity.
In addition, selection bias may have been occurred in the participation of residents in the eye examinations by the administration procedure for informed consent. As discussed by Elliot et al. [35], residents with known visual problems may have been excluded from the study if their legal representatives knew about their visual problems already and thus

decided against participation in the eye examinations. Gathering information on participation refusal was not conducted in this study and may be considered to be a limitation as well.
In this field study, measurements of light conditions were restricted to common rooms and corridors because these are the spaces where residents spent most of their time during the day. Furthermore, the distribution of illuminance during the day was not taken into account, because light conditions measurements were not taken continuously. The light conditions of individual rooms were not assessed. The arrangement of private rooms is usually conducted by residents and their families and not by professional caregivers. Nevertheless, in daily practice, the optometrist can provide advice on the illuminance levels of private rooms of residents in which low vision or eye diseases are detected.

### 4.5. Conclusion

Within the ICF model, professional caregivers in nursing homes, such as nursing home physicians, geriatric or gerontological nurse practitioners, nurses, and optometrists, may be considered to be an environmental factor. The availability of these caregivers and the quality of care provided by them may hinder or improve the residents' daily activities and participation. The availability of the caregivers is not only related to their physical presence but also related to their knowledge, experience and competencies.
This study showed that no information on visual functioning was found in the majority of client records of the residents referred for additional ophthalmologic consultation. Furthermore, if information on visual problems was recorded, this involved mostly information from the very past.
Additionally, the light conditions in common rooms and corridors in all nursing homes were of low or moderate quality.
The finding of poor light conditions in nursing homes in combination with a high prevalence of age-related eye pathologies (with cataract found to be the most common age related pathology), stretches the need of enhanced awareness of eye care by professional caregivers.

**Contributions**

MS and HK designed the study. MS and HK performed the data collection and analysis. MS, HK, MT, and JS prepared the manuscript.

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# 5

## Chapter 5 Eye Care by Dutch Nursing Home Physicians

**Also published in the Journal of Social Science Studies**

*Sinoo MM, Schols JMGA, van Tilborg MMA, Kort HSM. (2016). Eye Care by Dutch Nursing Home Physicians: A Descriptive Study. Journal of Social Science Studies, 3 (1), 222-237.*

**Abstract**

Currently, 4% of older adults reside in long-term care facilities in the Netherlands. Nursing home residents tend to have multimorbidity that is associated with considerable disabilities and a high level of care dependency. In the Dutch adult population the highest estimated prevalence (>40%) of visual impairment (low vision and blindness) was found in the subgroup of residents in nursing homes (NHs). The aim of this study is to describe the current practice of eye care by Dutch nursing home physicians (NHPs).
A digital online survey was developed to describe the eye care activities of nursing home physicians and their cooperation in this perspective with other professionals.
Of 1573 NHPs present in the Netherlands, 125 (8%) responded.
Results show that more than 50% of the NHPs regularly examine ‘distant vision’, ‘near vision’ and ‘the visual field’. However, 23%, 33% and 45% almost never or never examine the ‘visual field’, ‘near vision’ and ‘distant vision’, respectively. Data regarding eye care, regularly recorded in the client files by more than 50% of the NHPs, are medical data involving ‘use of eye medication’, ‘eye disease’, and ‘eye surgery in the past’. Less commonly recorded is ‘the use of reading glasses’ as well as ‘eye pain’.
Inside of the NH, (head) nurses and ward nurses ($chi^2 = 309$, df = 5, p = 0.000), and outside of the NH, ophthalmologists and low vision specialists are most frequently contacted about eye related issues ($chi^2 = 224$, df = 4, p = 0.000). Opticians are rarely contacted, and optometrists and orthoptists are ‘never’ contacted by more than 50% of the NHPs. Moreover, 50% of the NHPs noted that collaboration with external eye care professionals is ‘not structural’.
This study shows that, according to NHPs, relevant visual aspects are not structurally examined and recorded in the client files. Outside of the NH, NHPs tend to have a less frequent collaborative relationship with optometrists, orthoptists and opticians compared to ophthalmologists and low vision specialists. The NHP’s role in providing eye care can be improved by development of guidelines for structural eye screening, improvement of recording in client files, and exploring plus undertaking collaboration with other eye care professionals.

**Keywords:** Long-term care, Visual functioning, Quality of eye care

## 5.1. Background

### 5.1.1. Nursing home residents in the Netherlands

Currently, 4% (112,000) of older Dutch adults [mean age, 85 years [1] reside in long-term care facilities (www.rivm.nl). Nursing home residents tend to have multimorbidity that is associated with considerable disabilities and a high level of care dependency [2,3]. In addition, eye diseases are highly prevalent in this target group. In the Dutch adult population the highest estimated prevalence (> 40%) of visual impairment (low vision and blindness) was found in the subgroup of residents in nursing homes [4]. Deterioration of visual function can be caused by eye diseases, such as cataract, glaucoma, diabetic retinopathy and macular degeneration [5,6].

### 5.1.2. Nursing home care in the Netherlands

In Dutch nursing homes, care is delivered by multidisciplinary teams consisting of a nursing home physician (NHP), nurses, nurse assistants, and several therapists, including physiotherapists, occupational therapists, speech therapists, dieticians, psychologists etc. Nursing home medicine is a specifically acknowledged medical discipline (www.verenso.nl) [7]). In Dutch nursing homes, NHPs work in different types of wards, including psychogeriatric, somatic and rehabilitation wards. The NHP is based at the nursing home, and is responsible for developing and evaluating the integrated care plan. This is formulated for every resident after admission and after performing an integral assessment of his or her problems [8]. Secondly, the NHP supervises the care team in the execution of multidisciplinary care [9].
Eye care is also part of the integral nursing home care, and it impacts the health, comfort and wellbeing of residents [10]. In the case of visual problems, the NHP can also contact specialists working outside of the nursing home, including ophthalmologists, optometrists, orthoptists, opticians or low vision specialists. In the Dutch system this may require an out of facility visit.

### 5.1.3. Eye diseases and visual functioning

Residents with eye diseases fail in basic visual abilities and visual functioning, such as visual acuity, contrast sensitivity, and dark adaptation, as well as visual field loss [6,11]. Earlier studies have shown that eye problems are often insufficiently recorded in client files [11.12] and that light conditions in many nursing homes are of poor quality [13-15] and often below the recommended threshold for visual function in older adults (750 -1,000 lx) [14-16].

Therefore, this study aimed to examine both the role of NHPs in eye care and in this respect also the relationship between NHPs and other involved professionals, by using a survey from the NHPs perspective.

The following research questions were addressed:

1) How do NHPs currently practice eye care for nursing home residents?

2) Who are the NHPs' eye care collaboration partners inside and outside of the nursing home and how often do they cooperate?

## 5.2. The ICF model

The study is using the World Health Organization's [17] ICF model (International Classification of Functioning, Disability, and Health), because it provides a multi-perspective approach to classify function and disabilities. Moreover the ICF can be considered to be a model for understanding the relationships between the resident, nursing home environment, and outcome factors, such as resident activity and participation.

The ICF framework relates health conditions (disorders or diseases), body functions and structures, and environmental factors (building related aspects and social aspects), to activities and participation of residents. The interaction of these components for residents with eye disease is shown in Figure 5.1.

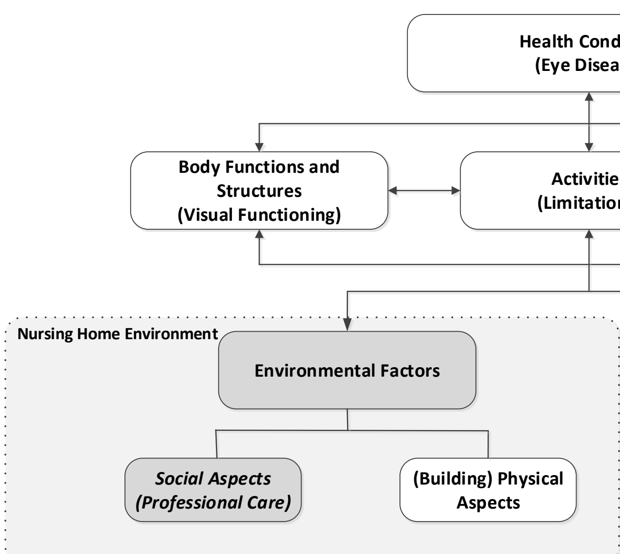



Figure 5.1. Professional care as a social aspect of the environmental factors, based on the ICF framework for disabilities and health [17]

Eye diseases as macular degeneration, glaucoma, cataracts or diabetic retinopathy [4,5] can be considered as "health condition" in the ICF model. These eye diseases may result in decreased visual functioning, due to decreased visual acuity, blurred vision, central vision loss or a reduction of the visual field [11]. Following ICF, this can be gathered under "body functions and structures". Both Body functions and health condition influence residents' daily activities and participation. (e.g. reading ability, social contacts). In ICF terms referred to as "activities" and "participation".

The environmental factors (Figure 5.1.) represent among others social aspects (such as attitudes of professional caregivers, institutions , and laws), as well as building physical aspects (such as air quality, acoustics and light conditions). In the ICF framework building or indoor environmental aspects can be seen as non-pharmacological interventions to support people's self-management or health conditions [18].

With respect to light conditions, the nursing home environment can be facilitative or a barrier in the sense of visual functioning or visual comfort [16]. The nursing home environment can even be a barrier in case of safety issues e.g. falls [19].

This study primarily focused on the social aspects of the nursing home environment. Among other things, social aspects involve all internal and external care professionals who collaborate in delivering eye care. This includes the recognition of visual problems, taking care of the treatment of visual problems and eye diseases and creating the best fitting environment for residents with visual problems. For the responsible care team, it is important to gain insight into both the visual problems of residents [20,21] and the context in which the residents are living [22].

## 5.3. Methods

A digital online survey was conducted using Survey Monkey software (www.surveymonkey.com). The research team developed the questionnaire which was set up in three parts, as shown in Table 5.1. In the first part, demographic data of the responding NHPs, such as gender and employment characteristics, were gathered.

Secondly, the screening and recording of visual problems were interrogated by forced choice questions and questions using a five-point Likert scale with the following choices: 1 = never, 2 = almost never, 3 = sometimes, 4 = frequently, and 5 = always.

In the third part the questions about the inter professional collaboration between NHPs and eye care professionals were asked by using a nominal scale with six choices: score one represented no structural collaboration and the other five choices represented structural collaboration with the ophthalmologist, optometrist, orthoptist, optician, or low vision specialist.

Prior to dissemination of the survey, a pilot of the questionnaire was tested for content (comprehensibility and feasibility) by four experienced NHPs, who participated on a voluntary basis. Based on their responses (sent by email) some minor revisions were suggested, and questions were adapted accordingly. These NHPs were allowed to participate in the survey.

Table 5.1. Outline of the set of questions

| Part | Topic | Question |
|---|---|---|
| 1 | General demographics | Year of birth?<br>Gender?<br>What is the year of your certification/registration as an NHP*?<br>In what type of ward are you employed? |
| 2a | Screening of visual functioning by the NHP* | How often do you examine aspects of visual functioning of the residents? (see Figure 5.2.) ** |
| 2b | Recording in the client's file | Indicate how often you record the listed data in the client's (medical) file. (see Figure 5.3.) ** |
| 3a | Inter professional collaboration in eye care inside and outside of the nursing home | How often do you contact the listed professionals or organizations if you suspect visual problems? (see Figure 5.4.) ** |
| 3b | Formal collaboration outside the nursing home | Which eye care services are you formally consulting in your nursing home? *** |

*NHP = nursing home physician.

** Scale: never, almost never, sometimes, frequently, always.

*** Six choices: 1, no structural collaboration; 2 through 5, structural collaboration with an ophthalmologist, optometrist, orthoptist, optician, or low vision specialist.

### 5.3.1. Recruitment of participants and data analysis

A link to the web-based survey was placed in the newsletter on the Verenso website www.verenso.nl. Verenso is the professional organization of nursing home physicians in the Netherlands. Over to 1500 members were able to read the newsletter. Thereby a potential sample of 1,573 NHPs could be approached. The link was available from April 15, 2013 to August, 16 2013. Six weeks after the first publication on the Verenso website on

April 15, a second reminder was provided on this website. No special incentives were used to increase the response rate.
Statistical analyses were performed using IBM Statistical Products and Service Solutions (SPSS) statistics 20 for Windows (IBM Corp., Armonk, NY: IBM Corp.) and Microsoft Excel 2010. For non-parametric statistics, the Friedman two-tailed test for k-related samples was employed to test differences in the frequencies of categories. The critical *p*-value was set at 0.05.

### 5.3.2. Ethical considerations

The survey submission was voluntary, and the data were received and processed anonymously. The only mentioned special point of interest was that the results would be published on the Verenso website for nursing home physicians. Verenso made no extra efforts to recruit participants. In the Netherlands, a survey considering collaboration is not needed to be reviewed following the Medical Research Involving Human Subjects Act (http://www.ccmo-online.nl).

## 5.4. Results

### 5.4.1. Demographic results

In January 2014, the total group of NHPs involved 1,573 physicians (males/females = 527/1,046) (www.verenso.nl).
In total, 125 (response rate < 10%) surveys were included in the analysis, seven of which were excluded. Only the data of the demographics were completed and all other data were missing. Table 5.2. shows the characteristics of the 118 nursing home physicians who fully completed the survey.

Table 5.2. Characteristics of the respondents (n = 118)

| **Gender** | ***f*** | **%** |
|---|---|---|
| Male | 37 | 31.4 |
| Female | 81 | 68.6 |
| **Total** | **118** | **100,0** |
| **Certificated NHP** | | |
| Receiving training | 10 | 8.5 |
| 2010 or later | 19 | 16.1 |
| 2000 - 2010 | 47 | 39.8 |
| Before 2000 | 42 | 35.6 |
| **Total** | **118** | **100,0** |
| **Employment** | | |
| Psycho Geriatric ward (PG) | 16 | 13.6 |
| Rehabilitation ward (R) | 10 | 8.5 |
| PG and somatic care | 46 | 39.0 |
| PG and R | 10 | 8.5 |
| PG, R and somatic care | 25 | 21.2 |
| Other | 11 | 9.2 |
| **Total** | **118** | **100,0** |

Thirty-seven of the respondents (31.4%) were male, and 81 (69%) female. This proportion is representative of the population of NHPs, which consists of 33.5% male and 66.5% female NHPs.

Among the respondents, 10 (8.5%) were in training to become a NHP and 19 (16.1%) were recently certified (2010 or later). Most of the respondents (47 or 39.8%) were certified from 2000 to 2010, and 42 (35.6%) were certified before 2000. The majority of the NHPs were employed in a combination of wards: psychogeriatric and somatic wards (39%), or psychogeriatric and rehabilitation wards (8.5%), or psychogeriatric, somatic and rehabilitation wards (21.2%).

### 5.4.2. Activities of nursing home physicians regarding eye care for Dutch nursing home residents

Figure 5.2. shows the median scores for the diagnostic activities of nursing home physicians in terms of the residents' eye functions (n = 116).

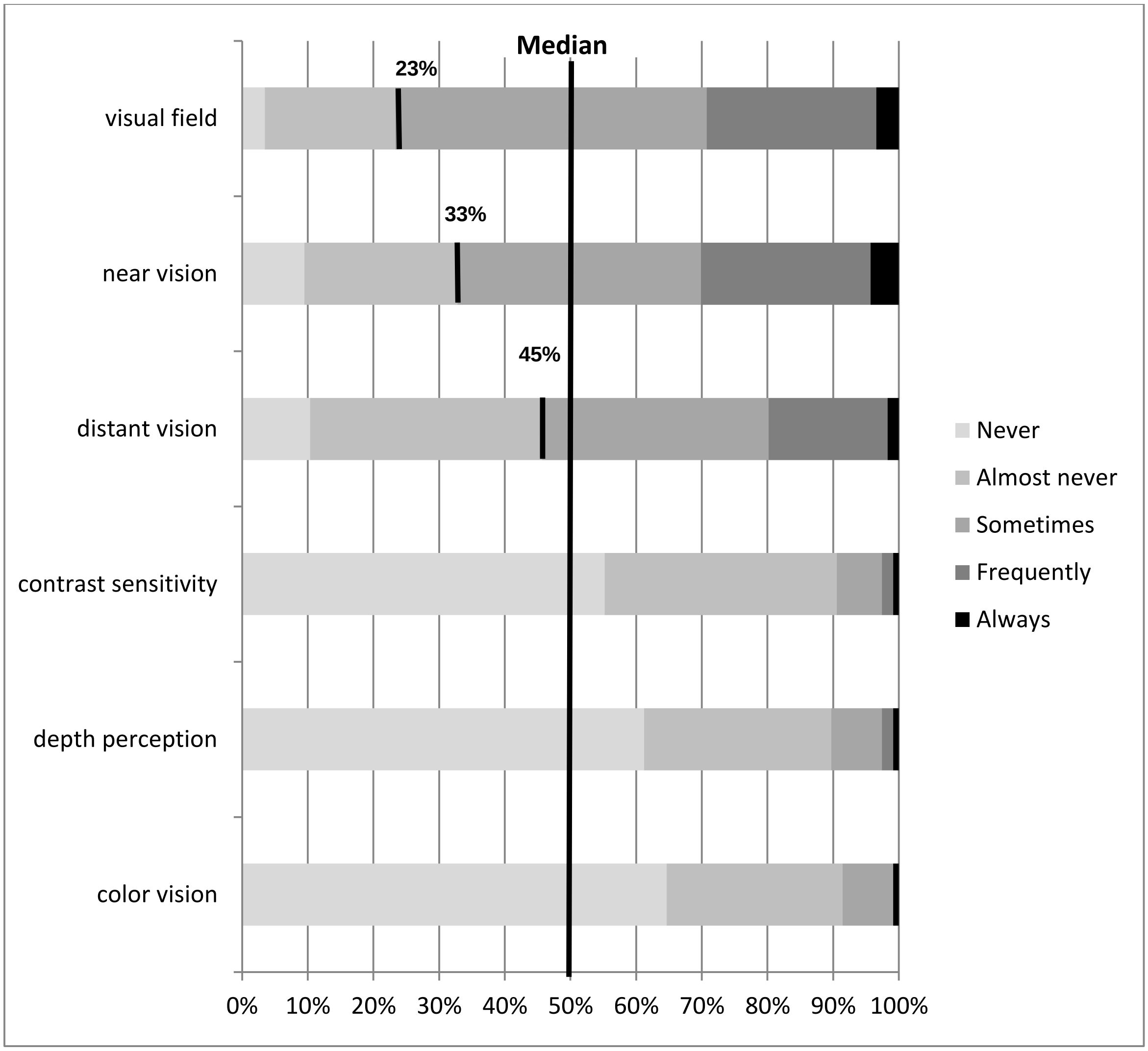
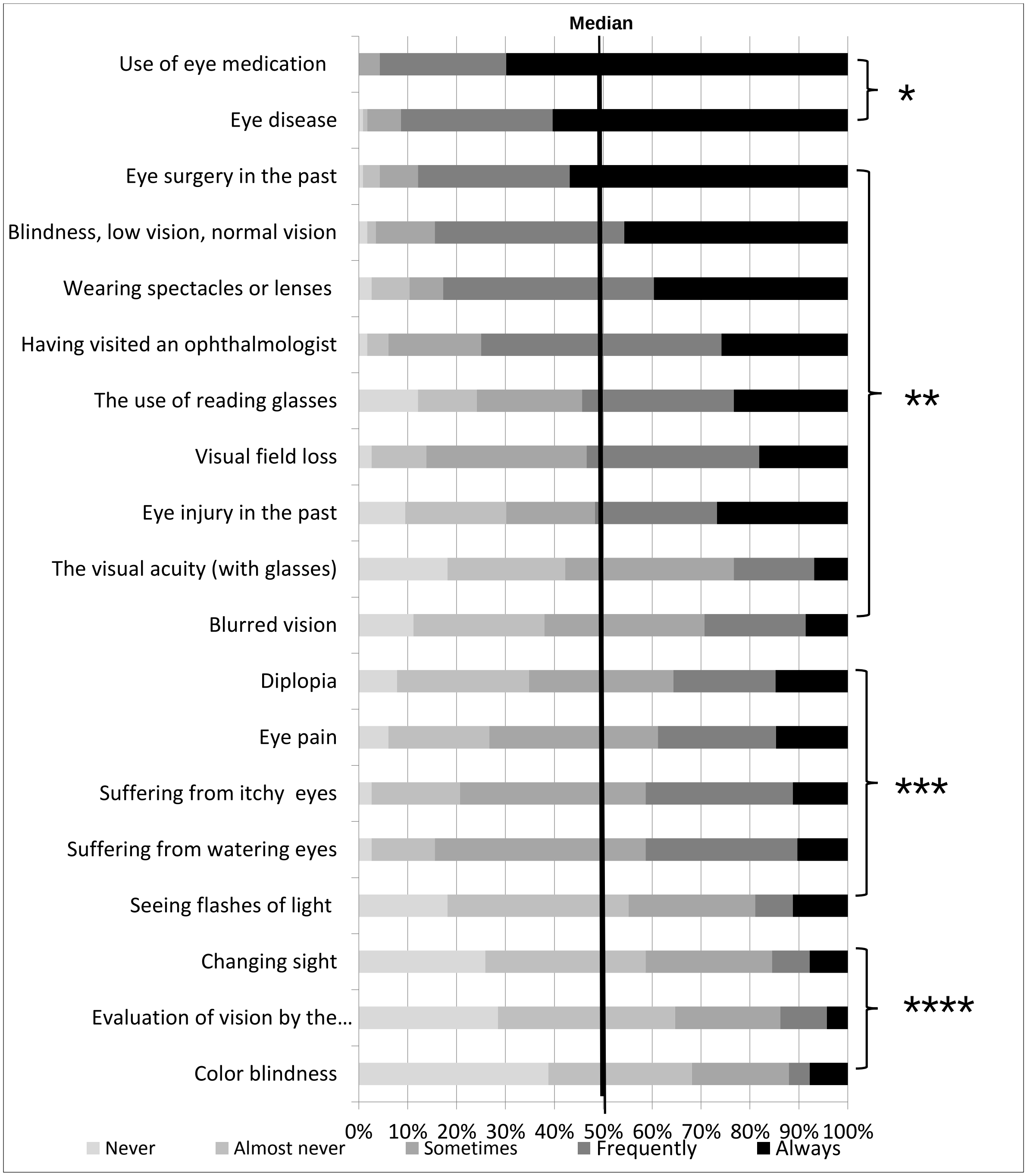



Figure 5.2. The visual aspects examined by the nursing home physicians (n = 116, 2 missing)

Some of the respondents almost never or never examine 'visual field', 'near vision' and 'distant vision' (23%, 33%, or 45%, respectively). Nevertheless these visuals aspects, are most frequently examined by the NHPs (Friedman: $chi^2$ = 383, df = 5, p = 0.000).
The median line shows that more than 50% of the respondents never examine 'contrast sensitivity', 'depth perception', or 'colour vision'. In Figure 5.3., the frequencies of eye-related issues (as recorded in the client files) are shown.




*Eye-related issues that are frequently or always recorded by at least 90% of the responding NHPs
**Eye-related issues that are frequently or always recorded by more than 50% of the responding NHPs
***Eye related issues that are recorded sometimes or less often (almost never or never) by more than 50% of the NHPs
**** Eye related issues that are almost never or never recorded by more than 50% of the NHPs

Figure 5.3. The eye related issues that are recorded in the client files, according to the nursing home physicians (n = 116, 2 missing; 'having visited an ophthalmologist' n = 115, 3 missing)

More than 90% of the nursing home physicians (*) frequently or always record ‘eye disease’ or the ‘use of eye medication’. Nearly 90% do record whether their residents had undergone ‘eye surgery in the past’. The eye related issues that are recorded frequently or always by more than 50% of the NHPs are marked by two asterisks (**).
With three asterisks (***) data are marked that are recorded sometimes or less frequently by more than 50% of the NHPs. Data that are recorded almost never or less by more than 50% of the nursing home physicians are marked with four asterisks (****) These data involved: ‘seeing flashes of light’; ‘changing sight’; ‘evaluation of vision by the resident himself, ’and ‘colour blindness’.

### 5.4.3. Collaboration with professional partners regarding eye care, inside and outside of the nursing home

In Figure 5.4., which is based on the ICF model, the median score of the frequency of contacting another professional inside or outside of the nursing home is calculated (i.e., in cases in which the NHP suspects eye problems in the residents).

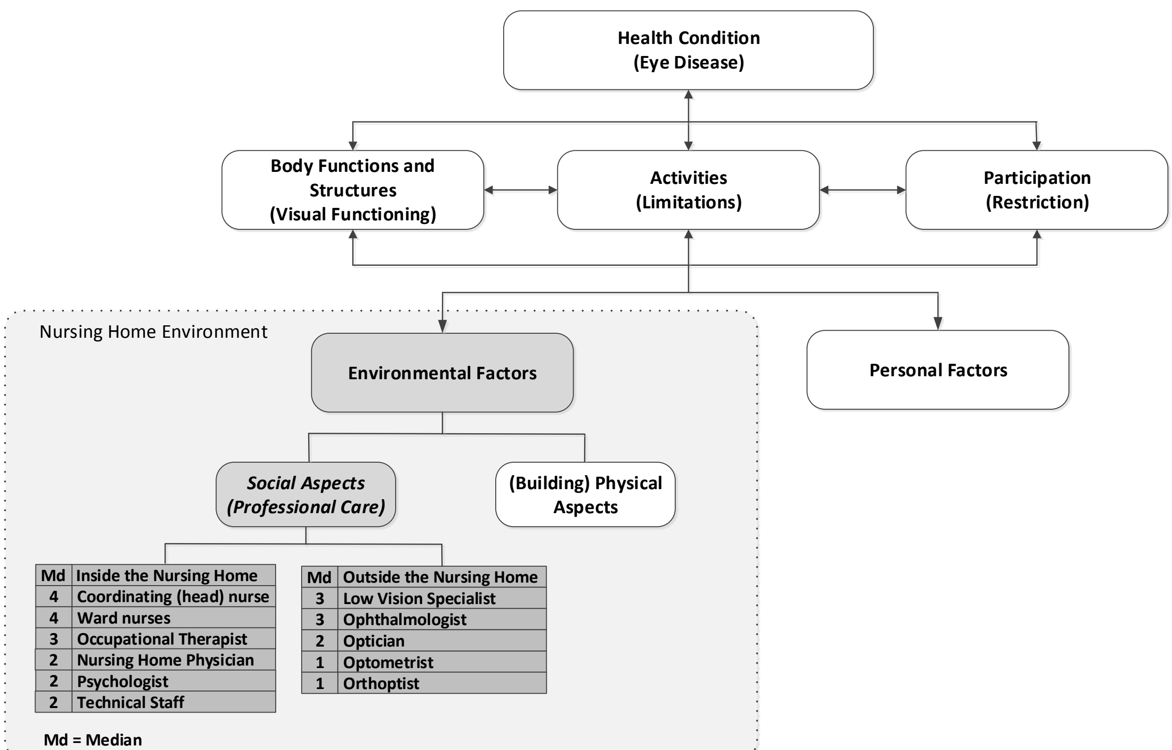



Figure 5.4. Median scores (Md) of contact with care professionals inside and outside of the nursing home, in case of suspected eye problems (illustrated as social aspects within the ICF framework): 1 = never, 2 = almost never, 3 = sometimes, 4 = frequently, 5 = always

Figure 5.4. shows the median scores of the extent to which care professionals inside and outside of nursing homes are contacted.

A significant difference was observed in terms of the extent to which the six professional caregivers inside of the nursing home are contacted (Friedman: $chi^2$ = 309, df = 5, p = 0.000).

More than 50% of the respondents 'almost never' (Md = 2) contact a colleague nursing home physician, psychologist or technical staff member. The coordinating (head) nurse or the ward nurse is 'frequently' contacted by more than 50% of the respondents (Md = 4). The occupational therapist is contacted 'sometimes' (Md = 3).

The extent to which the five professional caregivers outside of the nursing home are contacted differed significantly (Friedman: $chi^2$ = 224, df = 4, p = 0.000).

Ophthalmologists and the low vision specialists are contacted 'sometimes' (Md = 3) by more than 50% of the NHPs. Opticians, optometrists and orthoptists are contacted (almost) never (Md = 1 or 2).

The question whether the collaboration with eye care professionals, if present, can be considered to be structural by the NHPs was answered positively by nearly half of the respondents (49.6%); the other half (50.4%) did not consider this collaboration to be structural.

## 5.5. Discussion

Identifying visual problems is the first step in improving the quality of eye care in nursing homes. Older adults are advised to have a regular (once a year) eye screening even in the absence of established pathology [20]. In the Netherlands, the Dutch Ophthalmological Association recommends an eye examination for all nursing home residents upon admission [23]. This includes refraction, assessment of the anterior and posterior segments of the eyes, and intraocular pressure (IOP) measurements. This examination should be repeated every two or three years.

This study showed that not all NHPs conduct regular eye screenings. Therefore, it is still relevant for NHPs to be more aware of the importance of doing such eye screenings.

A first step in enhancing awareness of care professionals on visual problems might be the use of a feasible Visual Functioning Questionnaire (VFQ). The NEI-VFQ 25 questionnaire, for instance is originally developed by the National Eye Institute (NEI) in the USA, and provides a self-reported measure of visual functioning, which is associated with visual acuity, binocular status and differences in acuity between eyes [21]. Family or professional caregivers can complete this questionnaire. The NEI-VFQ 25 tool does not provide a complete picture. An eye screening or even an eye examination is still necessary for diagnosis of visual problems. Nevertheless, the questionnaire gives an insight into the experienced visual functioning. This may be a first step in enhancing awareness of care professionals on visual problems.

NHPs might also chose to collaborate in a more structural way with eye care professionals outside of the nursing home, such as ophthalmologists or optometrists. These professionals might be called in to further examination of the residents if (serious) visual impairment is suspected by the NHP or other nursing home professionals.

In this study, only half of the NHPs considered the collaboration with eye care professionals outside of the nursing home to be structural. In the professional profile of elderly care physicians (www.verenso.nl) their role is described as: 'objective-focused collaboration (i.e. network formation) is an absolute must'. Unfortunately, up until now adequate integral eye care for nursing home residents is not an established care pathway in the Netherlands. An established care pathway is a process of interprofessional collaboration and may be described by the four dimensions of D'Amour et al. [24].

Interprofessional collaboration, thereby, is defined as "the process in which different professionals work together to positively impact healthcare", according to Zwarenstein et al. [25].

D'Amour et al. [24] have developed a typology of collaboration of healthcare professionals /organizations expressed by four dimensions:

1). shared goals and vision, referring to the existence of common goals;

2). internalization, referring to the awareness of interdependence of care professionals;

3). formalization, referring to the use of documented procedures; and

4). governance, referring to leadership that supports collaboration.

The first two dimensions describe the relationship between professional caregivers and their awareness of interdependency. Interprofessional collaboration emphasizes that professionals value the expertise and contributions of other healthcare professionals.

In nursing homes, the first two dimensions of shared goals, vision and the awareness of interdependency regarding eye care implicate that the NHP and other internal and external health care professionals share data about the visual status of the residents. The coordinating (head) nurse and the ward nurses need this information to retrofit the environment by taking into account the residents' visual capacities.

Therefore visual functioning must be recorded in the client file to achieve appropriate tailor made care. This step is not always commonly conducted in a complete and tailored way, as is shown in this study. The most frequently recorded data on visual functioning and visual impairments by the NHPs in this study involved medical aspects, such as 'eye disease' or 'use of eye medication and whether residents had undergone 'eye surgery in the past'. Data as visual field loss, changing sight and suffering from itchy eyes were less frequently recorded.

The third dimension in the D'Amour typology is formalization [24]. In the Netherlands, however, establishment of a complete eye care model with external professionals such as ophthalmologists, optometrists, orthoptists and low vision specialists, is not yet formalized. This is an ongoing process. Currently, in some nursing homes in the Netherlands, NHPs are already able to consult an optometrist on demand.

In this study, the ICF framework was chosen as model. This framework relates environmental factors (building related aspects and social aspects) to activities and participation of residents. In earlier studies, the ICF framework was suitable to investigate light conditions, representing an environmental (building related) aspect of nursing homes [12,14].

In this study, the focus was on professional care and interprofessional collaboration, both representing environmental social aspects. We were able to investigate NHPs interprofessional collaboration related to eye care, with other professionals inside and outside of nursing homes. As described in Figure 5.1., interprofessional collaboration in eye care impacts health care in ICF terms, meaning that it limits or facilitates residents in their daily activities or in participation.

The Dutch professional organization of NHPs (Verenso), states that disorders of the special senses (vision and hearing) are a relevant and urgent point of interest (www.verenso.nl). Nevertheless, this study shows that NHPs' activities associated with the provision of adequate eye care in the nursing home can and must be improved in terms of more and regular eye screenings, better recording of information in the client files, and by interprofessional collaboration.

### 5.5.1. Study limitations

The most apparent limitation of this study is the low response rate (<10%). To generalize the findings of a survey, a response rate of 30- 80% would be reasonable; however, internet surveys typically have lower response rates than other types of surveys [25].

Nevertheless, the proportion of 31.4% male respondents, and 69% female respondents is representative for the total population of NHPs, which consists of 33.5% male and 66.5% female NHPs. In this study, some measures were adopted to increase the response rate, including the assurance of confidentiality and placing a reminder on the website.

In addition, the imperfect response rate, combined with the non-random sampling procedure may also have led to a selection effect in which, those who answered the survey may have had special interest in this topic. Overall this may lead to generalizability problems and therefore, one should be cautious in drawing overall conclusions.

Despite this, the results of this study fit with earlier field studies in Dutch nursing homes showing low awareness of care professionals on visual functioning [12,26].

## 5.6. Conclusions

This study shows that relevant visual aspects in nursing home residents are not structurally examined and recorded in client files and also that the inter professional collaboration in eye care can be improved. For the respondents in this study it requires a more proactive approach by NHPs themselves. In addition more attention must be paid to the development of an integral eye care model for nursing home residents including the relevant professionals of the internal multidisciplinary team and external specialized professionals, such as ophthalmologists, optometrists, orthoptists and low vision specialists.

## 5.7. Practical implications

Awareness of nursing home residents' visual functioning and insight into the consequences for daily functioning is highly relevant for adapting basic daily care from NHPs in alignment to the resident's needs.


**Acknowledgements**

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**Authors' contributions**

Research team: MS, JS; data collection: MS; data analysis: MS, JS, and HK; manuscript preparation: MS, JS, HK, and MvT

**List of abbreviations**

ICF: International Classification of Functioning; NHPs: Nursing Home Physicians;
NH(s): Nursing Home(s)

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# 6

## Chapter 6 A Nursing Home Staff Discussion Tool for the Indoor Visual Environment

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**Abstract**

In the Netherlands, over 40% of nursing home residents are estimated to have visual impairments. This results in the loss of basic visual abilities. The nursing home environment fits more or less to residents' activities and social participation. This is referred to as environmental fit. To raise professional awareness of environmental fit, an Environmental Observation tool for the Visually Impaired was developed. This tool targets aspects of the nursing home environment such as 'light', the use of 'colours and contrasts' and 'furnishing and obstacles'.

Objective of this study is to validate the content of the observation tool to have a tool applicable for practice.

Based on the content validity approach, we invited a total of eight experts, six eye care professionals and two building engineering researchers, to judge the relevance of the items. The Item Content Validity approach was applied to determine items to retain and reject.

The content validity approach led to a decrease in the number of items from 63 to 52. The definitive tool of 52 items contains 21 for *Corridors*, 17 for the *Common Room*, and 14 for the *Bathroom*. All items of the definite tool received an Item-Content Validity Index of ≥ 0.875 and a Scale-Content Validity Index of ≥ 0.62.

The content validity index of the scale and per item has been applied, resulting in a tool that can be applied in nursing homes. The tool might be a starting point of a discussion among professional caregivers on environmental interventions for visually impaired older adults in nursing homes.


**Keywords:** visual comfort, nursing home, environmental observation, quality of life.

## 6.1. Introduction

It is estimated that the population of older adults (> 65) in the Netherlands will increase from 3 million in the year 2015 to 4.2 million in 2030 [1]. Consequently, the group of institutionalised older adults in long-term care will grow up to > 350,000 in 2050 [2]. Low vision is very common among older adults. In the Netherlands, over 40% of nursing home residents are estimated to have visual impairments [3]. Decreased visual functioning may even serve as a contributing factor to the nursing home placement of older adults [4].
Visual impairments in nursing home residents due to cataracts, glaucoma, macular degeneration or diabetic retinopathy can result in the loss of basic visual abilities, such as visual acuity, contrast sensitivity and visual field loss [5,6]. This may affect the quality of life of these residents by limiting their daily activities such as reading and restricting their participation in activities such as watching television and social interaction [7]. In addition, earlier studies have shown that light conditions in the nursing home environment are poor [8,9]. The nursing home environment might or might not facilitate residents' activities and participation. This can be considered as the environmental fit, which this study describes using the framework of the International Classification of Functioning (ICF), published by the World Health Organisation [10] as shown in Figure 6.1.

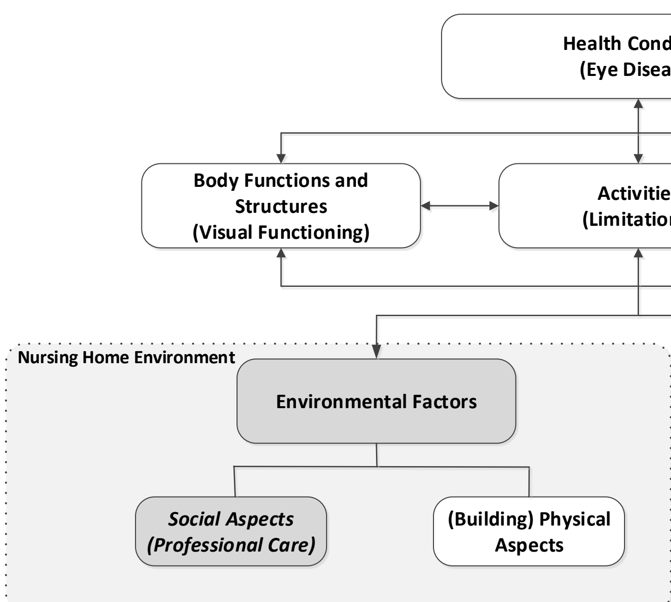


Figure 6.1. Shows the Interaction of the nursing home environment and nursing homes residents activities and participation, based on the ICF model [10].

In the centre of the ICF, the interaction of environmental factors, activities and participation of a resident with eye disease and affected visual functioning are shown. Environmental factors consist of social aspects or (building) physical aspects such as light (e240). Creating a healthy (visual) environment for nursing home residents is one of the tasks of professional caregivers in nursing homes [11]. As an environmental factor in the ICF model, professional caregivers themselves may improve the living environment by controlling light conditions, the use of colours and contrasts, and the arrangement of spaces [8,12-14]

The importance of awareness of nursing home residents' visual functioning has been addressed by former studies [6, 13-16].

A supporting tool might raise professional caregivers' awareness of these environmental factors, indicated as (building) physical aspects in Figure 6.1. In a pilot study [17], the content and layout of the Environmental Observation tool for the Visually Impaired (EOVI-63) was determined by use of a literature search and open observations in seven nursing homes. The tool was developed because previous studies showed that nursing homes had poor light conditions and because of professional caregivers' lack of awareness of these light conditions and their effect on the residents [15,16]. The tool targets indoor light related aspects of the nursing home environment, such as quality of light, the use of colours & contrasts and furnishing & obstacles, to prevent residents from falling. These aspects concern items in common rooms, corridors and bathrooms in nursing homes. From a practical point of view, and keeping the workload of professional caregivers in mind, the tool should contain a minimum number of items. In a pilot study, the observers needed 12-23 minutes to complete all the items [17].

The aim of the EOVI is to serve as a tool to observe light related aspects in nursing homes for interprofessional discussion about building physical aspects and visual functioning. This, to contribute to raise awareness of aspects of environmental fit. Therefore, only indoor environmental items that could be observed by professional caregivers without the use of any device have been adopted.

**Aim of the study**

To validate the content of the observation tool in order to have a tool applicable for interprofessional discussions.

## 6.2. Method

The items of the EOVI  were generated in a pilot study in two phases. In the first phase of the study a literature study was conducted to determine the environmental parameters that are linked to visual functioning and the environment. The environmental parameters and the items of the Environmental Observation tool for the Visual Impaired (EOVI) were determined in this phase. The items were derived by observations of the wards in seven nursing homes, on condition that an item would be general applicable and linked to one of the environmental parameters. In this way the first concept of the EOVI was available and ready for a first check on content validity.

The judgement by six experts (three eye care professionals and three engineering professionals) was conducted in a two round Delphi technique to confirm for the frame and in the second Delphi round for the individual items of the EOVI. Out of this a preliminary model for the final observation tool is constructed.

In this pilot study, the face validity of the first version of the EOVI with 63 items (EOVI-63) was formulated and judged as relevant by colleague researchers in eye care and building engineering. Furthermore, agreement was reached on the content of the EOVI-63, structured into the following environmental aspects: *light*, *colour & contrast*, and *furnishing & obstacles*. The items were judged for all three parameters of *common rooms* (n = 25 items), *corridors* (n = 23 items), and *bathrooms* (n =15 items) of a nursing home ward. Private rooms were excluded because they are furnished according to the taste and wishes of the resident or his/her family. In this study, the content validity of the EOVI-63 is tested.

### 6.2.1. Content validity

Content validity refers to “the sampling adequacy of items for the construct that is being measured” [18]. According to Polit & Beck [19], “content validity concerns the degree to which a scale has an appropriate sample of items to represent the construct of interest”. It is typically measured by the Content Validity Index (CVI). The CVI is based on the judgement of experts in the field of interest. The role of the experts is to advise the researcher concerning the relevance and formulation of the items. According to Polit et al. [20], there are three ways to determine the CVI: The proportion of relevant items per expert (E-CVI); the proportion based on the number of agreements per item (I-CVI), and the Scale Universal Agreement as the number of items rated relevant by all experts (S-CV/UA). In this study, we focus on the item quality. Therefore, the I-CVI and the S-CVI-UA are used to establish the content validity of the EOVI.

In the content validity approach of Polit & Beck [19], and Lynn [21], it is advised to invite five to seven experts but no more than ten. In this study, we invited a total of eight experts from our research and educational network: Six professional eye care experts and two researchers in the built environment. The experts were chosen because of their different specific knowledge in the fields of eye care and the built environment (2,7).The six professionals in eye care were an optician (1), a low vision specialist (6), an ophthalmologist (8), and three members of an assessment team of Bartimeus (3,4,5). This assessment team screens residents' (upon the request of a nursing home) on visual functioning and provides further referrals for ophthalmological consultation and rehabilitation possibilities. Bartimeus is a national expert centre that aims to improve the quality of life of the blind and visually impaired (www.bartimeus.nl). Screening of nursing home residents is one of its tasks, and in future assessments, it might even use the EOVI as a tool to raise nursing home care professionals' environmental awareness.

### 6.2.2. Analysis

To validate the content of the EOVI-63, the Item-Content Validity Index (I-CVI) and the Scale-Content Validity Index of Universal Agreement (S-CVI UA) were computed [19].
All eight experts were asked to judge the relevance of the items of the EOVI-63 on a 4-point rating scale (1 = highly relevant, 2 = relevant, 3 = slightly relevant, 4 = not relevant). In the results, scores 1 and 2 are considered as relevant (x) and scores 3 and 4 as not relevant (-). The (I-CVI) for each item was computed as the number of experts who judged the item as relevant (x) divided by the total number of experts.

$$\text{I-CVI} = \Sigma\, I_x / n_{etot} \qquad (1)$$

$\Sigma$=sum, $I_{x=}$ number of experts judging the item as 1.00 (relevant)
$n_{etot}$= total number of experts

If all items are considered relevant by the experts, the I-CVI = 1.00. According to the guidelines [19,21], an I-CVI ≥ 0.875 is considered to be the minimum agreement for eight experts, resulting in the removal of all items with a score < 0.875 from the EOVI-63.
Furthermore, the Scale-Content Validity Index of Universal Agreement (S-CVI UA) was computed for the subscales (s) *Corridors*, *Common Room*, and the *Bathroom* as the number of items rated as an I-CVI of 1.00 [all the experts judged the item as relevant (x)] divided by the total number of items.

$$\text{S-CVI UA} = \Sigma\, I_{1.00} / n_{itot} \qquad (2)$$

$\Sigma$=sum, $I_{1.00}$ = items judged as 1.00 (relevant)
$n_{itot}$ = total number of items.

Additional textual comments on the items were processed by the first author. The changed items were resubmitted for approval to all experts in a second round. If seven or more of the eight experts agreed on the changed item, it was changed. This resulted in a definite version of the EOVI, called the EOVI-52.

### 6.2.3. Translation-retranslation

A translated version of the EOVI-63 was needed for international publication. Therefore, a translation–retranslation (i.e., Dutch-English-Dutch) was performed, resulting in English and Dutch versions of the EOVI. However, in the content validity process, the experts judged only the items of the Dutch version.

## 6.3. Results

All eight experts judged the relevance of the 63 items of the first version of the EOVI.
Table 6.1. shows the results of the experts' opinions about the proposed items for the Corridors (23 items).

Table 6.1. Content validation of the Environmental Observation tool for the Visually Impaired EOVI-63 for Corridors (23 items)

| CORRIDORS n=23 items / EXPERTS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | I-CVI |
|---|---|---|---|---|---|---|---|---|---|
| **LIGHT** | | | | | | | | | |
| 1. The lamps provide bright white light. (Colours appear natural.) | x | x | x | x | x | x | - | x | 0.875 |
| 2. The lamps provide uniform illumination. (There is no sudden transition from light to dark.) | x | x | x | x | x | x | x | x | 1.00 |
| 3. The walls are light in colour. | x | x | x | x | x | x | x | x | 1.00 |
| 4. The floors are light in colour. | x | x | - | - | x | x | x | x | **0.75** |
| 5. Paintings are placed ensuring that light reflection and glare is prevented. | x | - | x | x | x | x | x | x | 0.875 |
| 6. At each window, bright light can be sufficiently shielded. *(Drapes or blinds are functional.)* | x | x | x | x | x | x | x | x | 1.00 |
| 7. Lighting is not only decorative, but specifically illuminates the floor. | x | x | x | x | x | x | - | x | 0.875 |
| 8. The floor and walls are matte. *(not shiny).* | x | x | x | x | x | x | x | x | 1.00 |
| **COLOUR & CONTRAST** | | | | | | | | | |
| 9. The flooring is of one colour. *(uniform, with no wild print).* | x | x | x | x | x | x | x | x | 1.00 |
| 10. The wall covering is one colour. | x | - | x | x | x | x | x | x | 0.875 |
| 11. The colours of the floor and walls are contrasting. (The floor is darker than the walls.) | x | x | x | x | - | x | x | x | 0.875 |
| 12. The hand railing on the wall is clearly visible. (The colour of the handrail contrasts with the background.) | x | x | x | x | x | x | x | x | 1.00 |
| 13. Doorsteps are clearly marked across their full width using a striking colour | x | x | x | x | x | x | x | x | 1.00 |
| 14. Glass doors are clearly marked with a strip at eye/chest height. | - | x | x | x | x | x | x | x | 0.875 |
| 15. Signs and icons are situated at, or just above, eye level. | x | x | x | x | x | x | x | x | 1.00 |
| 16. The letters on signs and icons are large. (and easily legible for all residents). | x | - | x | x | x | x | x | x | 0.875 |
| 17. The colours used in icons and letters on signs are easy to distinguish. | x | x | x | x | x | x | x | x | 1.00 |
| 18. The house number and nameplate are easily legible. | x | - | x | x | x | x | - | x | **0.75** |
| 19. There is a light within the call button. | x | x | x | x | x | x | x | x | 1.00 |
| 20. The door handle and door frames can be easily distinguished by colour and contrast. | x | x | x | x | x | x | x | x | 1.00 |
| **FURNISHING & OBSTACLES** | | | | | | | | | |
| 21. All obstacles are situated on one side of the corridor. *(such as fire extinguishers, hoists, medication table, wheelchairs and walking frames).* | x | x | x | x | x | x | x | x | 1.00 |
| 22. The house number and nameplate are placed at eye level. | x | x | x | x | x | x | - | x | 0.875 |
| 23. There is plenty of room to move. | x | x | x | x | x | x | x | x | 1.00 |

I-CVI = Content Validity Index per Item (≥ 0.875 item is maintained)
x = highly relevant or relevant, - = slightly relevant or not relevant
Experts: 1=optician, 2=building engineer, 3,4,5 assessment team visual functioning in nursing homes, 6=Low vision specialist, 7= building engineer, 8=ophthalmologist
**The bold I-CVI values** are NOT considered relevant by two or more experts.

The I-CVI scores of the *Corridors* in Table 6.1 show that two of the 23 items (item 4: “The floors are light in colour” and item 18: “The house number and name plate are easily legible”) are not considered “highly relevant or relevant” by two of the experts. Accordingly, these items are removed, resulting in 21 items for the *Corridors*. All experts endorsed thirteen of the *Corridor* items (I-CVI =1.00). The S-CVI UA with all *Corridor* items maintained is 0.57 (13/23). However, when the *Corridor* items of an I-CVI < 0.875 are deleted, the S-CVI UA is 13/21 = 0.62.

In Table 6.2., the results of the experts’ opinions about the 25 proposed items for the *Common Room* are shown.

Table 6.2. Content validation of the Environmental Observation tool for the Visually Impaired EOVI-63 for Common Room.

| COMMON ROOM n= 25 items EXPERTS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
|---|---|---|---|---|---|---|---|---|---|
| **LIGHT** | | | | | | | | | **I-CVI** |
| 24. Windows provide even room lighting. *(There is no transition from dark to light.)* | x | x | x | x | x | x | x | x | 1.00 |
| 25. The lamps provide bright white light. (Colours appear natural.) | x | x | x | x | x | x | - | x | 0.875 |
| 26. Activities are illuminated from behind the resident. | x | x | - | x | x | x | - | x | **0.75** |
| 27. During residents' activities, lighting can be adjusted for each individual. | x | x | x | x | x | x | x | x | 1.00 |
| 28. There is extra lighting at the tables and chairs to enable activities such as reading. | x | x | x | x | x | x | x | x | 1.00 |
| 29. At each window, bright light can be sufficiently shielded. *(Drapes or blinds are functional.)* | x | x | x | x | x | x | x | x | 1.00 |
| 30. The tabletops or worktops are matte. *(not shiny).* | x | x | x | x | x | x | x | x | 1.00 |
| 31. The mirrors and paintings framed under glass are placed ensuring that light reflection and glare are prevented. | x | - | x | x | x | x | - | x | **0.75** |
| 32. Chairs and other seating are near a window (where possible). | - | x | - | x | x | x | x | x | **0.75** |
| 33. It is possible to sit close to the television. | x | - | x | x | x | x | x | x | 0.875 |
| **COLOUR & CONTRAST** | | | | | | | | | |
| 34. There is difference in colour between the flooring in the living room and in the corridor. | x | - | - | x | - | x | x | x | **0.625** |
| 35. The clock is clearly legible. *(The hands and the numbers contrast with the background and are large enough.)* | x | - | x | x | x | x | - | x | **0.75** |
| 36. The chairs have a contrasting colour to the floor. | x | x | - | x | x | x | x | x | 0.875 |
| 37. The door handle and door frames can be distinguished by colour contrast. | x | x | x | x | x | x | x | x | 1.00 |
| 38. The switches and sockets contrast in colour with the wall and are at a reachable height. | x | x | x | x | x | x | x | x | 1.00 |
| 39. All the characters are at eye level and large/contrasting. | x | x | x | x | x | x | x | x | 1.00 |
| 40. Electrical wires or leads are concealed or have a contrasting colour to the wall and floor. | x | x | x | x | - | x | x | x | 0.875 |
| 41. The chairs have a contrasting colour to the floor. | x | x | - | x | x | x | x | - | **0.75** |
| 42. The tables have a contrasting colour to the floor. | x | x | - | x | x | x | x | - | **0.75** |
| 43. Upon laying the table, placemats or tablecloths used are plain in colour. | x | x | x | x | x | x | x | x | 1.00 |
| 44. Upon laying the table, the use of contrasting colours is taken into account. | x | x | x | x | x | x | x | - | 0.875 |
| **FURNISHING & OBSTACLES** | | | | | | | | | |
| 45. All corners on furniture are rounded. | x | - | - | x | x | x | x | x | **0.75** |
| 46. There are no protruding objects, including drawers or doors left (half) open. | x | x | x | x | x | x | x | x | 1.00 |
| 47. Doorsteps are marked across their full width with a line in a striking colour. | x | x | x | x | x | x | x | x | 1.00 |
| 48. There is plenty of room to move. | x | x | x | x | x | x | x | x | 1.00 |

I- CVI = Content Validity Index per Item (≥ 0.875 item is maintained)

x = highly relevant or quite relevant

- = slightly relevant or not relevant

Experts: 1=optician, 2=building engineer, 3,4,5 assessment team visual functioning in nursing homes, 6=Low vision specialist, 7= building engineer, 8=ophthalmologist.

**The bold I-CVI values** are NOT considered relevant by two or more experts.

The I-CVI scores in Table 6.2. show that eight of the 25 *Common Room* items are not considered “highly relevant or relevant” by two or more of the experts. Accordingly, items 26, 31, 32, 34, 35, 41,42, and 45 are removed, resulting in 17 items for the *Common Room*. All experts endorsed twelve out of all *Common Room* items (I-CVI=1.00). The S-CVI UA with all *Common Room* items maintained is 0.48 (12/25). When the items of an I-CVI < 0.875 are deleted, the S-CVI UA is 12/17 = 0.71.

Table 6.3. shows the results of the experts’ opinions about the proposed items for the *Bathroom* (15 items).

Table 6.3. Content validation of the Environmental Observation tool for the Visually Impaired EOVI-63 for Bathroom (15 items)

| BATHROOM n = 15 items — EXPERTS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
|---|---|---|---|---|---|---|---|---|---|
| **LIGHT** | | | | | | | | | **I-CVI** |
| 49. Mirrors and tiles do not cause blinding glare (by reflection). | x | x | x | x | x | x | x | x | 1.00 |
| 50. The lamps provide bright white light. (*Colours appear natural.*) | x | x | x | x | x | x | x | x | 1.00 |
| **COLOUR & CONTRAST** | | | | | | | | | |
| 51. The colour used for the floor is different from that of the walls. *(The floor is darker than the walls.)* | x | x | x | x | - | x | x | x | 0.875 |
| 52. Doorsteps are marked across their full width with a line in a striking colour. | x | x | x | x | - | x | x | x | 0.875 |
| 53. The hand railing on the wall is clearly visible. | x | x | x | x | x | x | x | x | 1.00 |
| 54. The door handle and door frames can be distinguished by colour and contrast | x | x | x | x | x | x | x | x | 1.00 |
| 55. The colour of the towels contrasts with the bathroom interior. | x | x | x | x | x | x | x | - | 0.875 |
| 56. The colour of the toilet seat contrasts with the colour of the toilet and bathroom interior | x | x | x | x | x | x | x | x | 1.00 |
| 57. The colour of the toilet roll holder contrasts with the toilet paper. | x | x | x | x | x | x | x | x | 1.00 |
| 58. The hot and cold water taps are labelled clearly. | x | x | x | x | x | x | x | x | 1.00 |
| 59. The accessories situated on the floor are clearly visible compared to the walls and floors, such as a laundry basket. | x | x | x | x | x | x | x | x | 1.00 |
| 60. The light buttons and alarm bells are clearly visible. | x | x | x | x | x | x | x | x | 1.00 |
| **FURNISHING & OBSTACLES** | | | | | | | | | |
| 61. There are anti-slip mats or tiles with structure. | x | x | x | x | x | x | x | x | 1.00 |
| 62. The sinks have rounded edges. | x | - | - | x | x | x | x | x | **0.75** |
| 63. Steps and doorsteps are clearly marked. | x | x | x | x | x | x | x | x | 1.00 |

I-CVI = Content Validity Index per Item (≥ 0.875 item is maintained)

x = highly relevant or relevant

= slightly relevant or not relevant

Experts: 1=optician, 2=building engineer, 3,4,5 assessment team visual functioning in nursing homes, 6=Low vision specialist, 7= building engineer, 8=ophthalmologist

**The bold I-CVI values** are NOT considered relevant by two or more experts.

The I-CVI scores of the 15 *Bathroom* items show that only one item is not considered "highly relevant or relevant" by two experts. Accordingly, item 62: "The sinks have rounded edges" is removed, resulting in 14 items for *Bathroom*. All experts endorsed eleven *Bathroom* items. The S-CVI UA with all bathroom items maintained is 0.73 (11/15). When the bathroom items with an I-CVI < 0.875 are deleted, the S-CVI UA is 11/14 = 0.79.

### 6.4. Discussion

In this study the emphasis was on the content validity of the EOVI-63. Eight experts in either eye care or building engineering established the content validity of the EOVI-63. As a result, 11 of the 63 items were deleted from the first version of the tool, resulting in the EOVI-52. The interaction of eye disease, visual functioning and environmental factors with activities and participation of nursing home residents can be addressed with ICF. In ICF, environmental factors consist of social aspects or (building) physical aspects. This is in congruence with the Home assessment of Person-Environment Interaction (HoPE) instrument, which was developed for offices [22]. Here, professional caregivers are described as part of the 'human environment' and distinguished from the 'non-human environment'. In ICF, the 'human environment' is described as 'social aspects' and the 'non-human environment' as 'building physical aspects'.

Only a few tools have been developed to target the environment of visually impaired older adults [23]. These tools are specific in addressing one or two components such as light and the use of colour and contrast or the use of technical devices. The items of the EOVI are partially based on the EVOLVE tool of Lewis and Torrington [24], a checklist for extra care-housing for people with sight loss, and the home-based assessment tool validated by Carignan, Rousseau, and Couturier [23].

In the EOVI-63, "Furnishing & Obstacles" is added as an extra aspect because of the risk of falling [25]. The experts in this study considered these items to be relevant.

During the content validity process, some experts discussed the use of layman terminology in the EOVI instead of professional building engineering terminology (e.g., reducing glare by "sun blinds" instead of using the term "a brightness controlling system"). According to the aim of the EOVI, we decided to use layman terminology instead of building engineering terminology.

Another limitation of the study might be that only the content validity of the Dutch version of the EOVI tool was tested. However, we expect that experts of different countries use the same body of knowledge and would judge the same items as relevant or not relevant. Only a study in an English-speaking country can confirm this assumption. However, such a study is not within the scope of the current study.

Furthermore, the English version and the Dutch version should be tested in practice to prove their support in raising the environmental awareness of care professionals. The tool might be a starting point for the discussion among professional caregivers of environmental interventions for visually impaired older adults in nursing homes.
Determination of content validity is based on the judgement and reasoning of the researcher which is validated by an expert panel. In future research the construct validity of the EOVI could be determined by obtaining objective measurements of light conditions and colours & contrast in a controlled setting.

### 6.4.1. Appraisal of the I-CVI

Polit et al. [20] discuss the acceptability of the I-CVI as an indicator of content validity. They state that the I-CVI shows advantages, as it focuses on the agreement of relevance and consensus of experts rather than on agreement per se. However, they criticise the I-CVI for the absence of an adjustment for chance. They state that "the I-CVI captures inter-rater agreement but not full inter-rater agreement". It is considered as a weakness that a 4-point rating scale is transferred into two categories of relevant (X) and not relevant (-) items. However, Polit et al. [20] propose an adjustment of I-CVI values for three to nine experts. They make an adjustment of the I-CVI for chance agreement (k*) and propose the evaluation criteria of 'fair', 'good' or 'excellent' for k* with eight experts. The I-CVI values of 1.00 and 0.875, found in this study with eight experts, are both evaluated as 'excellent'. The I-CVI value of 0.75 has a k* value of 0.72 and is evaluated as 'good' [20]. Nevertheless, we even excluded these items to reduce the number of items of the EOVI.

### 6.4.2. The number of experts included

In the content validation literature, a preference for seven experts, but a minimum of five is proposed as a sufficient level of control for chance agreement [20,21]. The determination of the number of experts is somewhat arbitrary but depends in this study on the content domain areas. The domain areas were vision, eye care and building engineering, but more eye care experts than building engineers were invited to evaluate the items of the EOVI. The reason for this difference in number of experts is that different eye care professionals (ophthalmologist, optician, optometrist, orthoptist, and low vision specialist) are involved in eye care services for nursing home residents in the Netherlands. Even so, the inclusion of the Bartimeus assessment team was important from a practical point of view. In future eye assessments in nursing homes, they might use the EOVI-52 as a tool to raise awareness concerning nursing homes' quality of light, use of colour & contrast and furnishing & obstacles.

Within the ICF model, the EOVI, consisting of 52 validated items, can be seen as an interacting tool between social and building physical aspects of the nursing home environment.
Since the content validation of the EOVI is established, the tool is ready for a complete validation study in a robust and diverse sample.

## 6.5. Conclusions

Eight experts in the field of eye care and building engineering validated the content of the EOVI-63. The content validity approach led to a decrease in the number of items from 63 to 52. The 52 items of the EOVI-52 consist of 21 items for the *Corridors,* 14 for the *Bathroom*, and 17 for the *Common Room*. The items represent the aspects *Light, Colour & Contrast,* and *Furnishing & Obstacles.* All remaining items received a rating of "highly relevant or relevant" from at least seven of the eight experts, making the I-CVI rating for each item ≥ 0.875. The EOV-52 will be more applicable for practice due to the established content validity and the reduction in items.

## 6.6. Practical implications

The tool might be used as a starting point for the discussion among professional caregivers of environmental interventions for visually impaired older adults in nursing homes.
Care professionals can use the EOVI tool to identify and discuss light conditions, the use of colour and contrasts, and the furnishing of the ward.

## Contributions

Study design: MS, HK, JS; data collection and analysis: MS, HK; manuscript preparation: MS, HK, ML, JS

The authors declare that they have no competing interests.

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# 7

## Chapter 7 General Discussion

## 7.1. Background

The Netherlands is experiencing significant ageing, resulting in a growing number of older adults. Multimorbidity increases with age, even more so if there is increasing frailty and disability, such as in nursing home residents. Impaired vision is one of the chronic disabilities relevant to frail older adults. Visual impairments influence adults' quality of life in terms of limiting their daily activities and social participation [1,2].

In this thesis, the International Classification of Functioning (ICF) model was used as a framework [1]. Building physical aspects and social aspects are components of the environmental factors within the ICF. Hence, the light conditions in the nursing home environment were explored in two ways: as a building physical aspect and as a social aspect.

Regarding the building physical aspect, illuminance levels and correlated colour temperature were measured in common rooms and corridors. In this thesis, the social aspect included the role of professional caregivers and technical staff in nursing homes: being informed of the visual functioning of residents as well as influencing the quality of light conditions.

The main aims of this thesis were to describe: the light conditions in nursing homes; the visual functioning of nursing home residents: the role of professional caregivers (especially the nursing home physician) in diagnosing and recording of visual problems:

and development of an observational tool for the nursing home environment for professional caregivers.

The specific objectives of this thesis were as follows:

- to explore the light conditions in Dutch nursing homes, as measured by illuminance levels ($E_h$ and $E_v$) and correlated colour temperature (K).
- to describe the vision problems of older adults residing in Dutch nursing homes in relation to the information documented in their care records.
- to combine age-related eye pathologies among nursing home residents with light conditions and the data recorded in client files.
- to examine the role of nursing home physicians (NHPs) in eye care, as well as their collaboration with other professionals involved in eye care.
- to develop and validate the content of an observation tool that is applicable to discussing the environmental factors that influence the visual functioning of residents among professional caregivers.

## 7.2. Methodology

In this thesis, the following research techniques were used:
Light conditions (illuminance and correlated colour temperature) in the participating nursing homes were measured by single spot measurements.
Optometrists from Bartimeus performed eye examinations of the residents in the participating nursing homes. Bartimeus is an organisation in the Netherlands that aims to improve the quality of life of the blind and visually impaired by providing personal advice, guidance, and knowledge.
The care reports of the participating residents were analysed for eye-related information.
A digital survey of nursing home physicians was performed to study their eye care-related activities.
Finally, an observation tool to evaluate, discuss and subsequently improve environmental aspects such as “light conditions”, use of “contrasting colours” and “design & obstacles” was developed, and its content validity was established.

## 7.3. Main aspects and findings of the thesis

As mentioned, in this thesis the International Classification of Functioning was used as a framework to explore the environmental factors related to the visual functioning of nursing home residents. The ICF is also used as a framework for research in the Centre for Innovations in Healthcare at Utrecht University of Applied Sciences. This framework illustrates that several contextual factors (environmental, personal and health related factors) do influence people’s activities and participation. The ICF framework is applicable for environmental factors influencing the activities and participation of frail older adults. The framework proved earlier to be applicable for building designs as well [2].
Light is not only essential for vision but also plays a role in regulating certain biochemical processes such as regulating one’s biological clock and sleep-wake rhythm [3]. Both light conditions and the presence and quality of professional caregivers (jointly considered to be environmental aspects in the ICF model) can influence the activities and participation of nursing home residents.
In general, the studies conducted in this thesis provided insight into the environmental factors of the ICF framework related to the visual functioning of nursing home residents. As mentioned above, the environmental factors were divided into light conditions representing the building physical aspects and professional caregivers representing the social aspects.
The main findings are:

- Nursing home residents in this study live in environments with low or moderate light conditions.
- Using structured eye examinations, optometrists observed visual problems in more than 40% of the participating frail older residents.
  These visual problems were rarely documented in the client's files.
- The collaboration between nursing home physicians and eye care professionals inside and outside of the nursing home needs improvement. Nursing home physicians have a central role in both vision screening and documentation of visual problems, as well as in governing the inter-professional collaboration related to adequate eye care.

Finally, to promote interprofessional discussion about the environmental design of the nursing home ward, a discussion tool was developed. This tool was introduced to fellow researchers in eye care and building engineering. The content validity of the Environmental Observation tool for the Visually Impaired (EOVI) was determined in the last section of the thesis.

The results of the different studies will be discussed in more detail in the following paragraphs.

### 7.3.1. Light conditions in nursing homes: the building physical aspect

Light conditions (illuminance levels and correlated colour temperature) were examined in seven nursing home buildings in the Utrecht region in the Netherlands. Both vertical illuminances as well as horizontal illuminance in the common rooms of these buildings fell significantly below the 750 lx threshold value in more than 50% of the measurements. Similar results have been found and reported in the literature in the United States, by Bakker et al. [4] and Charness & Dijkstra [5], and in Belgium, by De Lepeleire et al. [6] In our study, poor light conditions were found in the corridors as well as in common rooms. However, older adults need higher light levels (750-1,000 lx) due to, for instance, opacification of the lens as a result of the ageing eye [7].

Several studies show that high intensity lighting >1,000 lx or the use of daylight affects health, sleep, behaviour, and mood or cognitive disturbances, especially in patients with dementia [8-11]. On the other hand, some studies [7,12] show no relation between low light levels and the satisfaction of the study participants. Paradoxically, the older adults in those studies were satisfied with the low light conditions. This paradox can be explained by biases in satisfaction research that uses questionnaires, such as the tendency to answer positively caused by social desirability or the fear of reprisal [13].

In our study, the illuminance levels were combined with the measured correlated colour temperature and depicted in a Kruithof curve [14,15]. In this curve, the relationship between correlated colour temperature and illuminance and the perceived ambiance in offices is shown.

The majority of our data was within the boundaries of “pleasant light conditions”, as determined by Kruithof (see chapter 2, Figure 2.5.). However, approximately 40% of the data points fell below the lower boundary, meaning that these conditions were too dim and cool (appear bluish). Some values of the data points reflected an overly colourful environment (appear reddish). The exact implications of the use of Kruithof’s curve for the nursing home environment remain unclear and are an area for future research. The Kruihof curve shows the perceived ambience in offices, where younger adults are staying and needs further research for older adults. As Kuijsters et al. describe in their studies [16,17] to create a pleasant activating as well as a pleasant relaxing ambience, literature based on ageing [shows that the ambiences created for younger people need adaptation for older adults (increase of illumination levels saturated blue light avoided and colour pairs avoided). Furthermore Boyce [3] describes that there is a lot of variability in people’s responses to different CCTs. However, a consistent result is that high CCTs are considered unpleasant when high illumninances are used. Perceived ambience may also be different for older adults suffering from eye diseases as cataracts and glaucoma as described in chapter 2 (2.4.2.).

The finding of poor light conditions in nursing homes in combination with the high prevalence of visual problems (with cataracts found to be the most common age-related pathology) stresses the need for an enhanced awareness of light conditions in professional caregivers, combined with appropriate eye care.

In appendix 1 the time schedule of the data collection in the four nursing home organisations is shown. The assessment of visual functioning (VF) and analysis of the client record (CR) was scheduled from February 2009 till August 2010, while the light measurements were taken from October 2009 till March 2010. It reveals that the light measurements were not always taken at the same time as the VF and CR. In Chapter 4 the findings of the light conditions were related to the found pathology in the nursing homes. However only in building 5 of organisation 3 the light conditions were measured at the same time as the VF and the CR. Nevertheless the conclusion is formulated that poor light conditions in nursing homes in combination with a high prevalence of age-related eye pathologies stretches the need of enhanced awareness of eye care by professional caregivers.

### 7.3.2. Care professionals as a social aspect: assessment of visual functioning, documentation of data and collaborations in eye care

In the four participating nursing home organisations, consisting of seven nursing home buildings, 259 residents in total were willing to participate in an eye examination conducted by a qualified optometrist from Bartimeus. A third of these nursing homes residents had visual problems that required further examination by an ophthalmologist. In addition, their client files were analysed for eye care-related information. A significant proportion of the client records for the cases that needed further ophthalmological examination showed no recorded information on eye care-related information. A comprehensive resident assessment can influence the quality of the care plan and the quality of care, if accurately communicated and recorded [18]. The need for visual functioning data to be recorded is supported by studies showing a high level of visual impairments, reduced visual functioning or a high prevalence of eye diseases among older adults [19-23]. When visual functioning data are not accurately recorded, Wartman et al. [18] recommend nursing home staff to suggest or discuss modifications to the client records with their professional team. Visual functioning data need to be available in the minimum dataset (an assessment of each resident's functional capabilities that helps nursing home staff to identify health problems), and/or in the regular client files in which the assessments of each resident's functional capabilities and care problems are recorded. This is applicable for all care problems related to the quality of life of nursing home residents, such as oral problems [24], pressure ulcers, malnutrition and falls, as well as multi-sensory problems such as visual and hearing problems [25]. The quality of documentation clearly depends on the willingness of the care professionals to accurately record all necessary data in the client files.

In the Netherlands, the nursing home physician is responsible for both delivering medical care and directing the complex care processes of the residents. Therefore, the nursing home physician has a central role in both the screening of visual functioning and in monitoring the adequate recording of visual data in the client files. However, in the survey conducted among nursing home physicians (NHPs), only approximately 50% stated regularly examining certain aspects of visual functioning (chapter 5). A considerable group almost never or never examined these aspects.

Furthermore, the data that were recorded by NHPs in the client files were mostly not actual or relevant, only involving medical data such as ‘use of eye medication’, former ‘eye disease’, or ‘eye surgery in the past’. This is in line with research conducted in the USA by Owsley et al. [26]. This study on the documentation of eye examinations showed that 66% of the enrolled nursing home residents had no record of any eye examination. According to Wartman et al. [18], the information recorded has to be particularly meaningful to the

staff in terms of concrete needs of the nursing home resident, such as “needs to wear spectacles all day” or “sensitive to glare”.
The low awareness of screening, of documentation of eye and vision problems and also of the relevance of good eye care in the nursing home appeared to also be present in the collaboration of NHPs with external eye care professionals, which was not routine for 50% of the NHPs. In the Netherlands, the nursing home physician (contingently supported by a geriatric nurse practitioner) is responsible for both delivering residents’ medical care and directing their complex care processes. The care requirements of the residents are assessed in close cooperation with the patients, their families and other care professionals. In fact, a screening of visual problems is normally expected of the NHP, while in cases of suspected eye problems, an external specialist, such as an ophthalmologist, optometrist, optician, or low vision organization, has to be consulted.
In our study, opticians were rarely contacted, and optometrists and orthoptists were ‘never’ contacted by more than 50% of the NHPs. However, after an initial screening by the NHP, the last two professionals contribute additionally by performing more in-depth eye examinations as well as providing additional recording of relevant information in the client files.

### 7.3.3. Awareness of the environment among professional caregivers: the social aspect

The importance of the awareness of nursing home residents’ visual functioning and the importance of an adequate living environment design has been addressed by several studies [3, 26-29]. Only a few tools have been developed that address the environment of older adults with visual problems [29,30]. These tools are specific to one or two components such as light and the use of colour and contrast or the use of technical devices. In our study, an Environmental Observation tool for the Visually Impaired (EOVI) was developed as a tool for interprofessional discussion to raise professional caregivers’ awareness of vision-related (building) physical aspects. The tool addresses aspects of the nursing home environment, containing observational items such as ‘light’, the use of ‘colours and contrasts’ and ‘furnishing and obstacles’.
As the main purpose of this instrument was to promote discussion among professional caregivers, only indoor environmental items that could be observed by these professionals without the use of a device were adopted. Content validity methodology was applied and led to a final tool of 52 items containing items for *Corridors*, the *Common Room*, and the *Bathroom*.
The EOVI is ready for use as a discussion tool to prepare for environmental changes in the short and long term. Further research will determine whether the EOVI is helpful in

stimulating discussion about a healthy visual environment for older adults in general or even for individual residents with special needs due to eye disease. If individual adjustments for residents are found to be necessary, low vision specialists can support these efforts. Low vision specialists, as specialists in visual ergonomics, can focus on how the vision impairment affects a resident's daily living.

The EOVI tool is developed specifically to promote internal interprofessional discussion among caregivers to create a short- and long-term plan of action for the ward and its resident(s).
In this thesis, the care professionals were under-informed about the visual problems of the residents because of the low awareness of the relevance of vision problems and of the poor recording of these problems in the client files. Furthermore, the awareness of the light conditions of the nursing home environment proved to be low, as residents were living in rather 'dark' environments. Information about the environmental design (light, colour and contrast, and furniture and obstacles) can be gathered by using the EOVI. A multidisciplinary discussion within the nursing home about these items is the basis for creating a plan of action. The optometrist or low vision specialist, both as specialists in primary eye care, can even coach the professional caregivers using the EOVI as a discussion tool and stimulate discussion among care professionals and technical staff.

### 7.3.4. The ICF as a framework

The World Health Organization's model, the International Classification of Functioning (ICF), served as a framework in this thesis [1]. This model aims to promote the use of a common language among health care professionals and researchers to address health issues in daily life. In this study, it offered the possibility to integrate knowledge in the field of vision problems with environmental aspects. By using the ICF framework, it was possible to describe the environmental aspects affecting nursing home residents in relation to eye disease and visual functioning. The 'environmental factors' (building physical aspects and social aspects) of the ICF framework were applied. Physical aspects of the building involve indoor air quality, HVAC (heating, ventilation, air conditioning), light, acoustics and e-health [31]. In this thesis, the focus was on light. In other studies, the ICF framework has also been applied, and it has been integrated with the Model of Integrated Building Design (MIBD) by Rutten in the case of frail people with dementia [2, 32]. The use of these models combined two perspectives: the care recipient's perspective and that of the building fit. Applying the environmental factors of a building's physical and social aspects, as in this thesis, allows for a more contextual approach. In this field study, the context of the nursing home is important and was described from the perspective of nursing home residents with

visual impairments. The building physical aspects such as light conditions play a role in the design of the common rooms. Professional caregivers need to be aware of the quality of light in the event of reduced visual functioning. Also veiling and glare possibilities must be taken into account. Knowledge about light, eye disease and visual functioning is essential for care professionals. Nevertheless the technical staff is also involved by reflecting on the visual problems of nursing home residents when providing lighting systems.
The application of the ICF framework in this thesis (see Figure 5.4. in chapter 5) revealed that in the context of light conditions in nursing homes and the visual functioning of residents, several professional caregivers represent the social aspect. Their awareness of the visual functioning of the residents, the light conditions, and the design of the common rooms and corridors may influence the activities and participation of the residents. As a matter of fact, quality of care also means that care professionals such as nursing home physicians and ward nurses can change the quality of the light conditions, the use of colours and contrasts and the design of the common rooms and corridors in response to the visual problems of the nursing home residents. In Figure 7.1., the application of the ICF framework is shown as an overview of the thesis.

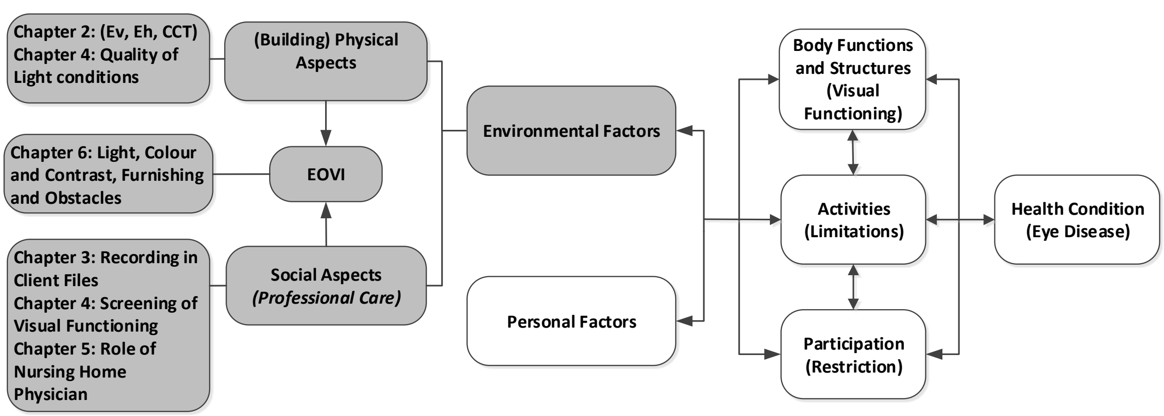


Figure 7.1. ICF and overview of the thesis

## 7.4. Methodological issues

### 7.4.1. Performing a field study

In Chapters 2, 3 and 4, the light conditions and visual functioning of the nursing home residents were obtained by conducting a field study. As described by Polit & Beck [33], a field study takes place in a naturalistic environment, which was represented by the building physical and social setting of the nursing homes in this thesis. The purpose was to gain an in-depth understanding of the environment and the visual functioning of the nursing home residents. The data collection was performed in seven nursing home buildings of four nursing home organisations, and 259 residents (or their family) agreed to participate in the study and to receive an optometric examination. In traditional scientific research, a heavy emphasis is placed on control and objectivity to obtain a high level of evidence. The aim of this thesis was to study the nursing home as it appeared at the moment of observation and to understand this context from the residents' perspective. This means that the lights remained off if they were off at the time of the observation.

In a field study, the research process is not linear but mostly begins with a general problem area to be explored (light conditions, assessment of visual functioning and recording), and further questions follow the data that are gathered in the first steps. In this thesis, the study of light conditions and the assessment of visual functioning was followed by questions concerning the awareness of care professionals of the visual functioning of the residents and the role of nursing home physician in this process.

Field studies are strongly realistic because they are conducted in naturalistic settings [33]. They provide a depth of understanding to the field, but replication might be difficult because the situations in the field change rapidly. As a result replication can lead to different conclusions; however, the results of this thesis are supported by other research studies [20,21,28].

The field study was a useful approach to gain an overview of the building physical and social aspects as environmental factors affecting nursing home residents. This revealed that in this study light conditions were poor (chapter 2 and 4) and that visual problems were not routinely examined and recorded in client files (chapter 3 and 5). Therefore, eye care and quality of light need to have a standardised role in nursing home care. These studies provided a rich basis for the development of the EOVI discussion tool (chapter 6).

### 7.4.2. The measurement of light conditions

In this thesis (chapters 2 and 4), single spot measurements were obtained when assessing the visual aspects of light. Vertical illuminances ($E_v$) at the eye gazing direction were taken as well as horizontal illuminances at table height or lap level($E_h$). To gain insight into the experiences of the nursing home residents when performing a task such as reading or leisure activity, point measurements were performed horizontally at table height (0.9 m) or at lap level to represent a seated position in a chair (0.6 m). The single spot measurements were assessed in places where residents resided to measure the situation as it appeared.

In this thesis, the single spot measurements do not represent the best case scenarios when using the combination of daylight and all-electrical lighting in nursing home wards. Instead, the measurements represent the naturalistic situation as it appeared at the time of observation. This means that sometimes, there was no electrical lighting at the time of measurement. To maintain some control and gain insight into daylight levels, measurements were taken from October until March between 10.00 am and 3.00 pm. Furthermore, the weather conditions of the measurement days were described.

Using continuous measurement devices throughout the whole day, to gain insight into the changes in daylight over the day, would be an interesting point for future research. However, by single spot measurements, the most illuminated places in common rooms in a nursing home can be detected.

Guidelines of illuminance levels of 500 lx are established for office buildings [34, 35] and working places. A state of the art report of TNO even proposes higher levels for older adults: illuminance level of 300 lx for corridors and 1,500-4,000 lx for reading tasks for older adults [36]. These illumination levels are based on the fact that older adults need more light. Nursing home residents though, are at risk for eye diseases and due to the ageing eye sensitive to glare and veiling reflections. Therefore, the individual needs of nursing home residents should be considered to tailor light conditions. Light conditions appropriate for one resident might hinder the other residents by causing glare. Hence future studies may focus on resident-tailored lighting control strategies in nursing homes.

### 7.4.3. Response rate of the survey with nursing home physicians

In the Netherlands, the nursing home physician (NHP) is responsible for developing and evaluating integrated care plans in the nursing home. Furthermore, the NHP supervises the care team in the implementation of multidisciplinary care.

In chapter 5, an online survey was conducted to study NHPs' activities related to eye care as well as their collaborative activities in this field. A low response rate (< 10%) was found in this study.

However, the benefit of an online questionnaire is that potential respondents can be invited easily. To prevent a low response rate, it is recommended to personally invite NHPs to participate in the study, for instance during their yearly conference. In this study, NHPs were invited via the newsletter published by their professional organization in the Netherlands (Verenso). After six weeks, one reminder followed. Nevertheless, this resulted in a low response rate. In the survey, non-responders and their reasons for non-participation were unknown. In future research, this needs to be taken into account. Furthermore, a limitation of the survey was that actual behaviour was not studied. In the questionnaire, the NHPs reported on their eye care-related actions, but we did not study their actual professional behaviour in this regard. Their answers could have been affected by social desirability. This is known as the attitude-behaviour relationship, as described by

Festinger in the seventies of the last century [37]. A disjuncture between attitudes and actions may be caused by external influences that mitigate internal attitudes. Internally, NHPs may be willing to screen for visual problems. However, external influences such as acute care problems of nursing home residents or multimorbidity may cause a change in the priorities of their initial screening and recording of visual problems.

## 7.5. Recommendations for daily practice

### 7.5.1. Eye care and the environmental context

In daily care, awareness of residents' visual functioning is a prerequisite for adapting basic daily care and for modifying the environment to the resident's needs. Problems with visual functioning should be assessed and captured in client records. This thesis shows that relevant visual aspects are not routinely examined and documented in client files. The NHP's role in providing adequate eye care (screening, referral to adequate care and documentation) is a prerequisite for raising additional environmental awareness of the quality of light in nursing homes. Furthermore, with the EOVI data, nursing home staff may have actionable items to improve the environmental conditions such as light conditions, the use of colours and contrasts, and the design of the common rooms. If aware of these conditions, staff might, for instance, encourage residents to be seated next to a window when performing a task or during meals.

### 7.5.2. Structural collaboration related to improving eye care inside and outside of the nursing home

As eye care is an integral component of nursing home care, the nursing home physician in the Netherlands is responsible for providing a preliminary screening of eye problems. To improve internal collaboration inside of the nursing home, vision screening outcomes need to be communicated with the staff and subsequently recorded in the client files to serve as the basis for any additionally required interventions.

More structural collaboration in the chain of eye care with professionals outside of the nursing home improves the quality of eye care in nursing homes. This type of collaboration in the chain of eye care is established by consulting an ophthalmologist, optometrist, orthoptist, or an optician on a regular basis. Even a low vision centre can be consulted regularly.

In chapter 6, the EOVI-52 is presented as a discussion tool. The tool connects the social and building physical aspects of the nursing home environment. Care professionals can use the EOVI tool to identify and discuss the light conditions, the use of colour and contrasts, and the furnishing of the ward in a structured manner. Further implementation of the tool can be tested in nursing homes or by optometrists or low vision organizations visiting nursing homes to conduct eye examinations. During the eye examination visits, these professionals can examine the nursing home environment as well and advise accordingly. In future research the application of the tool in practice must prove if the tool will raise additional awareness of professional caregivers on visual functioning of nursing home residents, the recording of visual functioning in client records and the quality of light of the environment.

## 7.6. Recommendations for future research

Light-related environmental factors within the ICF framework are explored in this thesis.
With an origin in health care, the ICF framework has shown to be applicable in building science because it combines “demands and supplies”, or “building physics and the needs of older adults” [38].
According to the ICF, the design of the nursing home building contributes to the activity and participation of the nursing home residents.
In this thesis, the multidisciplinary team within the nursing home as well as the eye care professionals outside of the nursing home are discussed as the social aspect of the ICF environmental factors (chapter 3). In Figure 7.3., the care professionals who have a central role in diagnosing and recording visual problems are shown. The roles are described as a collaborative activity in paragraph 7.6.1. and 7.6.2.

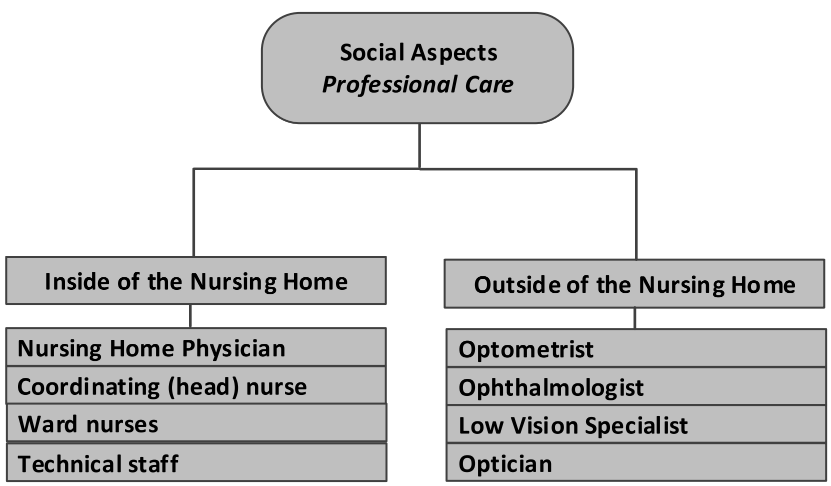


Figure 7.3. Care professionals with a central role in diagnosing and recording visual problems

### 7.6.1. Collaboration inside of the nursing home

As an integral component of nursing home care in the Netherlands, the nursing home physician is responsible for providing a preliminary screening of eye problems. In the event of visual problems, care professionals such as the coordinating (head) nurse and the ward nurse can influence the clients' personal care. An adaptation of the environment can be discussed in the multidisciplinary team with the nursing home physician, nurses, occupational therapist, psychologist and technical staff. A prerequisite for this discussion is the assessment of the visual functioning of nursing home residents and the documentation of the results in client records. Insight into visual impairments creates opportunities for professional caregivers to improve the environment. The EOVI can reveal whether building physical aspects are adapted in line with the needs of the residents. As a discussion tool, it can support a mutual exchange of ideas on the environmental design of the nursing home ward. When asked for assistance, technical staff can adapt the environment, while being aware that current lighting guidelines are not specifically developed for frail older adults.

Hence, awareness of improving the indoor environment of nursing homes among technical professionals is as important as having awareness among care professionals. In general, it is important that care professionals are aware that older adults need more light than younger persons to perform the same tasks and that they ask for technical assistance when needed.

### 7.6.2. Collaboration outside of the nursing home

In the event that there is a need for further eye examinations, external eye care professionals such as ophthalmologists or optometrists can be consulted. If eye diseases such as cataracts, glaucoma, macular degeneration or diabetic retinopathy are suspected by the nursing home physician, a referral to an ophthalmologist is indicated.

For further diagnosis, the nursing home physician can also consult the optometrist. The optometrist's scope of practice in a nursing home setting includes not only the assessment of eye disease and visual impairment [20,21] but also the quality of the environment (illuminance levels) and communication with the multidisciplinary nursing home team regarding record-keeping. These roles are consistent with the scope of practice of the optometrist in the provision of services "to enhance vision and protect health" [39] and "to advise on the use of optical and non-optical aids" [40]. In addition to the diagnosis of visual problems, optometrist services could be structurally implemented in Dutch nursing home care. In a model proposed by Limburg and Keunen [41], it is stated that if causes of low

vision or blindness, such as eye diseases and refractive errors, are detected in nursing homes, more than half of the cases (63%) can be treated or prevented from further decline. As shown in this thesis (chapter 5), only half of the NHPs considered their collaboration with eye care professionals outside of the nursing home to be routine.
Yet, this collaborative role and building of a professional network is described in general as 'an absolute must' in the professional profile of elderly care physicians (www.verenso.nl). Unfortunately, adequate integral eye care for nursing home residents has not been an established care pathway in the Netherlands to date, despite the fact that it is known that residents would considerably benefit from this service.

### 7.7. Reflection on the findings and further relevant steps

This thesis is an exploring field study and the results must be considered as a starting point for raising awareness on eye problems of nursing home residents, both for practitioners and technicians.

This thesis does not solve all the problems themselves.
The data collection of this thesis started In 2008 as a collaboration between Bartimeus (an organisation that aims to improve the quality of life of the blind and visually impaired), four nursing home organizations and the Utrecht University of Applied Sciences. The project was financed by SIA-RAAK, a foundation that focusses among other fields on processes and products for daily professional care. Supported by their management, professionals seek cooperation with partners in a (regional)setting of knowledge infrastructure to achieve a process of useful knowledge circulation. In 2008 Bartimeus visited nursing homes on demand for the assessment of visual functioning of the residents. A collaborative program (SIA project number 2008-6-5P) was initiated which focused on improving the knowledge of health care professionals with regard to eye care problems in frail older adults. The program aimed to raise awareness of the visual functioning of nursing home residents among healthcare professionals. Since SIA RAAK stimulates regional knowledge circulation, nursing home organizations in the region of Utrecht were invited to participate. The program also aimed and succeeded to gain knowledge of the building environment, of the nursing home and about the context of eye care in the nursing home. The results of this project are primarily related to the participating organizations, but are also interesting for the Dutch nursing home sector as a whole. The project results and its educational deliverables (incl. e.g. a seven minutes DVD about the experience of living in a nursing home with visual impairment, and a brochure published by the centre of expertise for long-term care "Vilans" [42]) can be used in the development of a broader strategy to improve the care for nursing home residents countrywide.

This strategy may involve:

- Raising countrywide awareness of the relevance and importance of the issue of vision problems in nursing home residents. This can be achieved by countrywide dissemination of the results and acquired knowledge of this thesis to target groups on different levels in the nursing home, including nursing home directors, managers, nurses, physicians, paramedics etc. and also to experts of the building environment incl. architects, technicians, and installers.
- Developing and executing multidisciplinary guidelines on eye care in the nursing home with attention for: a) adequate assessment tools for vision problems in residents themselves but also related to the quality of light of the nursing home environment (e.g. the EOVI-tool); b) developing adequate resident-oriented care plans for residents with vision problems; c) adequately executing the eye care activities by practitioners and nursing home physicians for residents with vision problems and d) monitoring and regularly evaluating the care for residents with vision problems.
- Developing and executing tailored educational programs for all professionals involved (healthcare and technicians) and to implement the guidelines.
- Empower residents and their family caregivers via information about light conditions in nursing homes for preferred daily functioning and social participation.

The improvement strategy should be accompanied by relevant additional and supporting research activities to make, on the one hand, parts of the strategy more evidence based. For instance by further development of the EOVI discussion tool to an actual measurement tool, accessible for practitioners that, which as mentioned above, can be adopted in a multidisciplinary guideline for eye care in the nursing home. On the other hand by studies that evaluate the effect and feasibility of the overall improvement strategy.

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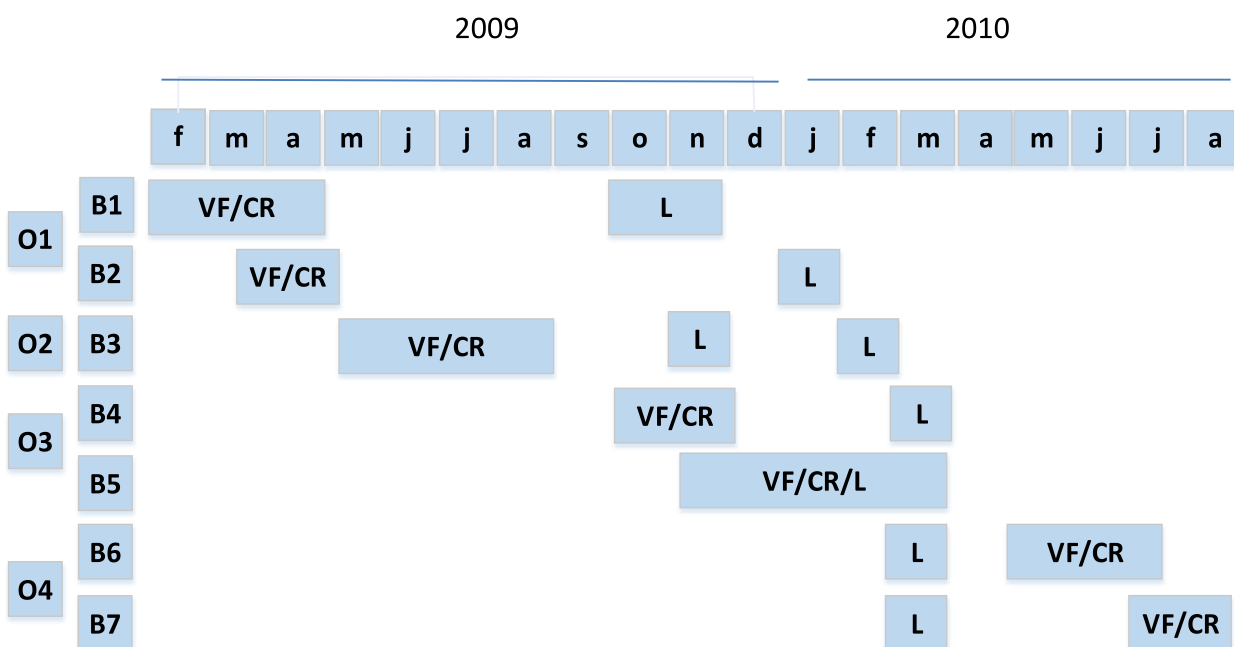
## Appendix 1. Chapters 2, 3, 4: Time Schedule Data Collection




O1-O4 = Organisation 1-4
B1-B7 = Nursing Home building 1-7
VF = Visual Functioning assessment
CR = Client Record analysis
L = Light measurements

## Appendix 2. Chapter 2: light conditions single spot measurements

| | $E_v$ | $E_h$ |
|---|---|---|
| Corridors | 1.6 m | x |
| Common Rooms | 1.6 m | |
| Common Rooms all tables | | 0.9 m |
| Common Rooms all armchairs | | 0.6 m |

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Marianne Sinoo, september 2016

**Curriculum Vitae**

Marianne Sinoo (1955) finished her combined Master Degree in social psychology and organisational psychology in 1983. From 1986 she teaches research methodology and statistics at the Hogeschool Utrecht, and from 1988 -2000 as a honorary teacher at the Master of Science Degree in Nursing of the University of Wales College of Medicine.
From 2000 -2013 she is senior lecturer in teaching research methodology and statistics at the healthcare courses of optometry and orthoptics. Since 2006 she is appointed as a researcher at the Research Centre for Innovations in Healthcare of the Hogeschool Utrecht. Since 2008 she is involved in education of courses for nursing home physicians and geriatric nurses. From 2009 onward she is a member of the editorial board of Nurse Academy, a digital educational journal in the Netherlands.
In June 2012 she received the Herman Bouma Award for the ISG master class at the TU/Eindhoven in recognition of her poster contribution to the gerontechnology research.
From 2013 she is advising different healthcare courses of the Utrecht University of Applied Sciences on research.

## Publications

### *2016*

Sinoo MM, Kort HSM, Loomans MGLC, Schols JMGA. (2016) A nursing home staff tool for the indoor visual environment: The content validity. Journal of Nursing Education and Practice, 6 (11), 25-34.

Sinoo MM, Schols JMGA, van Tilborg MMA, Kort HSM. (2016) Eye Care by Dutch Nursing Home Physicians: A Descriptive Study. Journal of Social Science Studies, 3 (1), 222-237.

### *2015*

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