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LOW VISION

Visual impairment and blindness in institutionalized elderly in Germany

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Abstract

Purpose To determine the prevalence of and identify factors associated with visual impairment and blindness in institutionalized elderly in Germany.

Methods In this prospective multicenter cross-sectional study, ophthalmic health care need and provision were investigated in institutionalized elderly in 32 nursing homes in Germany. All participants underwent a standardized examination including medical and ocular history, refraction, visual acuity testing, tonometry, biomicroscopy, and dilated funduscopy. A standardized questionnaire was used to identify factors associated with eye healthcare utilization, visual impairment and/or blindness.

Results Visual acuity of 566 (94.3%; 413 women and 153 men) of a total of 600 institutionalized elderly was determined. Mean age of the included patients was 82.9 years (± 9.8). Of all participants, 30 (5.3%; 95% CI 3.4–7.2%) were blind and 106 (18.7%; 95% CI 15.5–21.9%) were moderately or severely visually impaired according to the World Health Organization definition. The 136 blind and moderately or severely visually impaired participants were older (OR, Odds Ratio = 1.1, 95% CI 1.0–1.1; $p < 0.001$), and more likely to have reduced mobility (OR = 12.6, 95% CI 2.8–57.6; $p = 0.001$).

Conclusion A high proportion of blindness and visual impairment was found amongst nursing home residents. Age and reduced mobility were factors associated with an increased likelihood of blindness and visual impairment. Any surveys of blindness and visual impairment excluding nursing homes may considerably underestimate the prevalence of visual impairment and blindness.

Keywords Aging · Low vision · Visual loss · Blindness · Nursing homes

Introduction

Population aging will lead to a substantial increase in visual impairment and blindness as many causes of vision loss are age-related [1]. With increasing age, a growing proportion of people is cared for in nursing homes, which is why visual impairment and blindness are particularly frequent amongst institutionalized elderly [2–4].

Elderly persons living in nursing homes have a high prevalence and incidence of blindness and visual impairment for a number of reasons including age [5, 6], reduced independence leading to institutionalization [7], lack of access to services [8], chronic age-related diseases [9, 10] and dementia [7, 11, 12].

Knowledge of factors associated with visual impairment and blindness amongst this hard-to-reach group is essential. As this population will grow steeply in the next decades, health services must be planned according to need [13–15]. These include services to prevent avoidable visual impairment, the use of visual aids, and the adjustment of the living environment to the needs of visually impaired and blind institutionalized elderly, as their mobility and orientation are affected by their visual impairment [16].

In order to substantiate this for Germany, the OVIS (*Ophthalmologische Versorgung in Seniorenheimen*, German for: Ophthalmological care in nursing homes) study was initiated, which was implemented during 2014–2016. This study investigated factors associated with visual impairment and blindness in institutionalized elderly in order to allow for more tailored eye healthcare planning and provision.

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Patients and methods

Study design and participants

The OVIS study was a multicenter cross-sectional study and was performed amongst residents of nursing homes from 2014 to 2016 nationwide in Germany. The study followed the tenets of the Declaration of Helsinki and was approved by all local ethic committees. Informed consent was obtained from each participant or their legal guardian after explanation of the nature and possible consequences of the study.

In Germany, a broad spectrum of homes and residences for the elderly exist, offering a very wide range of individually adjusted care and support. In the OVIS study, only residents in need of constant nursing care provided by examined nursing staff were included (classified into level of care 0 to 3 according to German regulations pertaining to nursing care insurance, in German *Pflegestufe 0–3*). The higher the level of care, the more support is needed [17].

All university and major eye hospitals within Germany were invited to participate in this study. Of a total of 38 contacted centers, 14 (37.6%) agreed to participate as study centers. Nursing homes located close (radius of 50 km) to these study centers were contacted and invited to participate. Response rate was variable. Of a total of 73 contacted nursing homes, 32 (43.8%) agreed to participate. Interviews and examinations were performed by ophthalmologists and orthoptists.

All institutionalized elderly people living in the 32 nursing homes were invited to participate. Out of a total of 3127 institutionalized elderly people, 607 (19.4%) agreed to participate. Three participants were excluded due to missing data, two were only in short-term care and two were younger than 50 years, leaving a total of 600 subjects.

Data on ophthalmic health care need and provision, i.e., barriers to ophthalmic health care, was already published in 2017 [15].

Examination

The standardized examination was conducted as previously described in the nursing homes and included a detailed medical and ocular history, refraction, visual acuity testing, tonometry, biomicroscopy, and dilated funduscopy [15].

Detailed history was obtained by interviewing each participant or, in cases of inability to respond to interview questions, their carers. The standardized interview included demographic characteristics, medical and ophthalmic history, the use of eye-care and general medical services, self-reported problems with vision, and a variety of other variables. Self-reported problems with vision were captured by a standardized questionnaire with Yes/No answer options. Medical conditions including ophthalmic history were also self-reported, for which we used standardized questions as well as an open-ended question at the end of the interview which allowed participants to report any medical issue not covered. The questionnaire was interviewer-administered. Visual acuity was measured as follows: first, presenting visual acuity using a Snellen chart at 5 m distance with the subject's own habitual distance correction (that is, eyeglasses or contact lenses, if any) and then, best corrected visual acuity using autorefraction was assessed. Visual field deficits—in the absence of a meaningful examination—could not be systematically taken into account.

Definitions of blindness and visual impairment levels

As the definition of blindness and visual impairment differs widely around the world, we used the World Health Organization (WHO) criteria for blindness and visual impairment [18], which define seven categories of visual impairment: WHO visual impairment category 0 or mild or no visual impairment refers to a best-corrected visual acuity of equal to or better than 6/18 (Snellen 20/60) in the better eye, WHO visual impairment category 1 or moderate visual impairment refers to a best-corrected visual acuity of less than 6/18 (Snellen 20/60) in the better eye, and equal to or better than 6/60 (Snellen 20/200). Severe visual impairment or WHO visual impairment category 2 is defined as best-corrected visual acuity of less than 6/60 (Snellen 20/200) and equal to or better than 3/60 (Snellen 20/400) in the better eye. WHO visual impairment categories 3 to 5 are subsumed as blindness, where category 3 implies a best-corrected visual acuity of less than 3/60 (Snellen 20/400) and equal to or better than 1/60 (Snellen 20/1200), category 4 a best-corrected visual acuity of less than 1/60 (Snellen 20/1200) and at least light perception, and category 5 no light perception, all in the better eye. WHO visual impairment category 9 refers to undetermined or unspecified visual acuity.

Statistical analysis

Pseudonymized data were collected using a paper-based case report form (CRF) and entered into an electronic data base. A random sample of 20% of the CRF data was double-entered and checked manually for errors. Data were also checked for plausibility and missing or wrong data were queried and corrected. For the analysis, all visual acuity data were converted into logMAR.

All data were first analyzed descriptively using appropriate absolute and relative frequencies for categorical data and medians and quartiles/means and standard deviations for continuous data. Exploratory analyses were performed by means of the Student's *t* test, the Kruskal-Wallis test (continuous data) and the Pearson's chi-squared test (categorical data). Factors found univariately associated with moderate or severe visual impairment or blindness were evaluated by means of multiple

Table 1 Moderate visual impairment (WHO category 1 of visual impairment; < 6/18–≥ 6/60 in the better eye), severe visual impairment (WHO category 2 of visual impairment; < 6/60–≥ 3/60 in the better eye), and blindness (WHO category 3–5 of visual impairment; < 3/60 in the better eye), stratified for age and gender in the examined sample of institutionalized elderly, respectively

Variable	Total no.	Moderate visual impairment $n = 95$	Severe visual impairment $n = 11$	Blindness $n = 30$
Age (yrs)[a]	*n*			
50–59	14 (2.5%)	0 (0.0%)	0 (0.0%)	1 (3.3%)
60–69	46 (8.1%)	2 (2.1%)	0 (0.0%)	1 (3.3%)
70–79	110 (19.4%)	12 (12.6%)	3 (27.3%)	5 (16.7%)
80–89	240 (42.4%)	49 (51.6%)	2 (18.2%)	10 (33.3%)
90+	153 (27.0%)	30 (31.6%)	5 (45.5%)	13 (43.3%)
Gender				
Female	413 (73.0%)	74 (77.9%)	8 (72.3%)	23 (76.7%)
Male	153 (27.0%)	21 (22.1%)	3 (27.3%)	7 (23.3%)

[a] Age of 3 of the participants is missing

logistic regression modeling (forward model selection based on Likelihood Ratio tests); results of the exploratory model building were then described by factor-wise odds ratio estimates with nominal 95% confidence interval (i.e., not formally adjusted for multiplicity) and corresponding *p* values of Wald tests. The Nagelkerke R^2 served as summary indicator of achieved model fit; *p* values less than 0.05 were considered as indicators of locally statistical significance. Statistical analyses were performed by means of the SPSS software package Statistics 23 (SPSS Inc., Chicago, IL, USA).

Results

Six-hundred participants fulfilled the inclusion criteria of the study. Of these, visual acuity could be collected in 566 participants (94.3%). Of the participants with visual acuity data, 413 (73.0%) were female and 153 (27.0%) male. Mean age was 82.9 years (± 9.8). In this cohort, dementia was known in 26.9% of the elderly. 5.7% had the highest German level of care (level 3), and 2.3% of the participants were found to be bedridden.

In 34 participants (5.7%), visual acuity was not assessable due to medical reasons such as severe dementia. Mean age of these 34 participants was 82.6 years (± 9.6), which was not significantly different to the mean age of the other 566 participants. Of these 34 participants, 38.4% were male, 61.8% were known to have dementia, 46.7% had the highest German level of care, and 26.5% were bedridden.

When assessing visual acuity in the better eye with the participants' own habitual spectacle correction if available, the number of participants with moderate visual impairment (WHO category 1, as defined in methods), severe visual impairment (WHO category 2), and blindness (WHO categories 3–5) was 128 (22.6%), 14 (2.5%), and 31 (5.5%), respectively. When assessing best-corrected visual acuity (BCVA) using an autorefractor, the number of participants with moderate visual impairment, severe visual impairment, and blindness decreased to 95 (16.8%), 11 (1.9%), and 30 (5.3%), respectively (Table 1). Uncorrected refractive error was thus the cause of visual impairment in 36 (25.4%) participants, and legal blindness in one (3.2%) participant (Table 2).

Of the 142 participants with either moderate or severe visual impairment on BCVA examination, age-related macular degeneration (AMD) of any stage was present in 60 (42.3%), late stage AMD in 25 (17.6%), any cataract in 66 (46.5%), clinically relevant cataract in 55 (38.7%), glaucoma in 16 (11.3%), and other retinal or optic nerve diseases in 12 (8.4%). In the 31 blind participants, any AMD was detected in 18 (58.1%), late stage AMD in 13 (41.9%), any cataract 12 (38.7%), clinically relevant cataract in 6 (19.4%), glaucoma in 5 (16.1%), and other retinal or optic nerve diseases in 7 (22.6%) (Table 2).

Table 2 Distribution of ocular diseases or refractive error among participants with visual impairment or blindness as defined by WHO criteria

	Visual Impairment $n = 142$	Blindness $n = 31$
Ocular diseases		
AMD (all stages)	60 (42.3%)	18 (58.1%)
Late AMD	25 (17.6%)	13 (41.9%)
Cataract	66 (46.5%)	12 (38.7%)
Visually relevant cataract	55 (38.7%)	6 (19.4%)
Glaucoma	16 (11.3%)	5 (16.1%)
Diabetic retinopathy	3 (2.1%)	1 (3.2%)
Corneal opacities	3 (2.1%)	3 (9.7%)
Other retinal damage	6 (4.2%)	3 (9.7%)
Refractive error	36 (25.4%)	1 (3.2%)

The rate of previous cataract surgery increased markedly with age. 10.9% of all participants in the age group of 60 to 69 years were pseudophakic, 30.0% for 70 to 79 year-olds, 54.4% in 80 to 89 year-olds, and 72.9% in 90 year-olds and above ($p < 0.001$). Mean visual acuity of the better eye of pseudophakic participants was 0.36 logMAR (± 0.44) vs. 0.42 logMAR (± 0.46) in phakic participants ($p = 0.133$).

The 136 participants with moderate or severe visual impairment or blindness, excluding refractive causes, were older (86.1 years ± 7.7 vs. 82.0 ± 10.1; $p < 0.001$), had a higher level of care ($p < 0.001$), and were more likely to be bedridden ($p < 0.001$) compared to the 430 participants with mild visual impairment or no visual impairment (Table 3).

Via multiple regression modeling (Nagelkerke $R^2 = 0.15$ as an indicator of encouraging model fit), factors showing univariate association with moderate or severe visual impairment, were re-evaluated: higher level of care, poor physical condition (self-reported), and dementia were not significantly associated with at least moderate visual impairment or blindness any more, whereas being bedridden (OR, Odds Ratio = 12.6,

Table 3 Descriptive information on the sample of the visually impaired or blind institutionalized elderly concerning socio-demographical and clinical baseline characteristics, excluding refractive errors ($n = 136$)

Patient characteristics		Visually impaired or blind/rate of visual impairment or blindness ($n = 136$) mean ± SD or n (%)	Unadjusted p value[a]
Age		86.1 ± 7.7 (24.0%)	$p < 0.001$*
Gender	Male	31/153 (20.3%)	$p = 0.202$
	Female	105 /413(25.4%)	
Smoker		12/64 (18.8%)	$p = 0.094$
Physical condition (self-reported)	Good	57/290 (19.7%)	$p = 0.026$*
	Moderate	52/208 (25.0%)	
	Poor	19/58 (32.8%)	
Ophthalmological examinations	Every year	35 (25.7%)	
	Every 2–5 years	39 (28.7%)	$p = 0.195$
	Unknown or less than every 5 years	62 (45.9%)	
German level of care (nursing care dependency)	None	6/39 (15.4%)	p < 0.001*
	1	49/281 (17.4%)	
	2	53/177 (29.9%)	
	3	12/30 (40.0%)	
Mobility	Mobile	39/225 (17.3%)	$p < 0.001$*
	Dependent on rolling walker	32/132 (24.2%)	
	Dependent on wheel chair	54/195 (27.7%)	
	Bedridden	10/13 (76.9%)	
Hearing impairment		7/21 (33.3%)	$p = 0.309$
Arterial hypertension		87/388 (22.4%)	$p = 0.187$
Diabetes mellitus type II		37/154 (24.0%)	$p = 0.999$
Dementia		48/152 (31.6%)	$p = 0.011$*
Other documented systemic diseases:	Skin diseases	12/36 (33.3%)	$p = 0.177$
	Musculoskeletal conditions	51/233 (21.9%)	$p = 0.319$
	Nephrological diseases	23/100 (23.0%)	$p = 0.791$
	Urological diseases	16/47 (34.0%)	$p = 0.093$
	Cardiovascular diseases	60/233 (25.8%)	$p = 0.422$
	Other vascular diseases	18/93 (19.4%)	$p = 0.249$
	Pneumological diseases	18/87 (20.7%)	$p = 0.428$
	Psychiatric disorders	34/174 (19.5%)	$p = 0.096$
	Endocrinological diseases	58/261 (22.2%)	$p = 0.352$
	Neurological diseases	84/359 (23.4%)	$p = 0.644$
	Gastrointestinal diseases	25/116 (21.6%)	$p = 0.484$
	Malignant diseases	20/79 (25.3%)	$p = 0.773$

[a] Indicating local significance at the 5% level, p values not formally adjusted for multiplicity

95% CI, 2.8–57.6, $p = 0.001$) and age (OR = 1.1, 95% CI, 1.0–1.1, $p < 0.001$) were significantly associated with at least moderate visual impairment or blindness (Table 4).

Discussion

In this study, we found a high percentage of moderate or severe visual impairment and blindness among institutionalized elderly which was mostly due to age-related eye diseases such as AMD, cataract and glaucoma. The rate of age-related eye diseases increased steeply with age, except for cataract, where the rate of cataract surgery increased with age. Being bedridden and of reduced mobility, higher age and dependency on assistance with activities of daily living were highly associated with moderate or severe visual impairment and blindness. These results indicate that institutionalized elderly have an increased need for eye healthcare provision as well as multiple barriers which impede service provision and access.

With 5.3% blind and 18.7% moderately or severely visually impaired institutionalized elderly in our study, there seems to be a considerable excess of blindness and visual impairment in this population compared to non-institutionalized populations 75 years and older with approximately 1% prevalence of blindness and 5% of visual impairment [19–21]. In fact, we found roughly five times as much visual impairment and blindness in institutionalized elderly compared to prevalence rates reported for community dwelling elderly. Our numbers are consistent with the Melbourne Visual Impairment Project (VIP) institutional cohort, conducted in 1995, and the Baltimore nursing home study, conducted from 1988 to 1989 [2, 3]. Thus, overall population trends of decreasing blindness and visual impairment do not translate to the institutionalized elderly [20]. This finding is consistent with the results of a mathematical model developed by Limburg and Keunen, which did not show any decrease in blindness or low vision in this vulnerable subgroup between 2008 and 2020 [22].

As ophthalmologists do not regularly visit nursing homes and transport and lack of support were the main barriers to accessing healthcare providers [15], novel models of healthcare provision need to be thought of for this hard-to-reach population. These could include but should not be limited to eye screenings by trained medical personnel or nurses, training of nursing home staff in detecting and managing visual impairment, and a better adjustment of nursing homes as such to cater to a visually impaired population. Additionally, access to cataract surgery and refractive corrections (i.e., glasses or other visual aids) should be facilitated as these are very cost-effective options to easily reduce visual impairment.

Our finding that AMD is the leading disease associated with moderate or severe visual impairment in the elderly

Table 4 Binary multiple logistic regression modeling results (Odds Ratios with unadjusted 95% confidence intervals) of covariates associated to visual impairment and/or blindness as defined by WHO criteria (Nagelkerke $R^2 = 0.15$ as measure of overall model fit)

Covariates	Binary logistic regression of factors associated to visual impairment and/or blindness according to WHO			
	Odds ratio	CI (95%)		p value (Wald test)
Age	1.1	1.0	1.1	$p < 0.001$[a]
Physical condition (self-reported)				
Good			Reference	
Moderate	0.9	0.6	1.5	$p = 0.765$
Poor	1.4	0.7	3.1	$p = 0.365$
Level of care				
None			Reference	
1	0.9	0.4	2.5	$p = 0.896$
2	1.5	0.5	4.1	$p = 0.475$
3	1.3	0.4	5.0	$p = 0.658$
Mobility				
Mobile			Reference	
Dependent on rolling walker	1.1	0.6	2.0	$p = 0.686$
Dependent on wheel chair	1.5	0.8	2.7	$p = 0.170$
Bedridden	12.6	2.8	57.6	$p = 0.001$[a]
Dementia	1.4	0.8	2.2	$p = 0.194$

CI (confidence interval)

[a] Indicating significant p values of Wald tests at the 5% level

is consistent with epidemiological data from other reports from high-income countries [2, 5, 21, 23, 24]. In the Baltimore nursing home study, AMD causing legal blindness (defined as a BCVA of equal to or less than Snellen 20/200 in the U.S.) was observed in 20% of the Caucasian participants [3]. In the Blue Mountains Eye study, late AMD was the cause of blindness (defined as a BCVA of equal to or less than Snellen 20/200 in Australia) affecting one or both eyes of 12% of residents [4]. With 44%, the VIP institutional cohort also found AMD to be the leading cause of moderate or severe visual impairment [2]. The Rotterdam Eye study also reported AMD to be the main cause of blindness in people aged 75 years and older [21]. Consistent with these published data, we found late stage AMD to cause 40.0% of blindness in our cohort.

The strengths of our study include its large sample size with data from 32 different nursing homes, thus providing a broad and supraregional overview of visual impairment and blindness in institutionalized elderly in Germany. In this study, however, we likely underestimated the proportion of moderate or severe visual impairment and blindness as visual acuity was not performed in the very frail participants. Furthermore, a double-positive selection bias is likely, since healthier and more active nursing home residents as well as more motivated and caring nursing homes more likely agreed to participate in this study. As such, we did not assess a representative sample of nursing homes or their residents in this study and results need to be interpreted keeping this in mind. In addition, we are unable to report anything about persons refusing to participate as no data could be collected, thus no statements on how general or eye health or present visual impairment might have impacted the decision to participate are possible. Considering available data, the mean age (83 years) of the participants in our study is similar to the mean age in nursing homes in Germany (82 years), indicating that our sample might be comparable in its age distribution to the overall nursing home population in Germany [25]. Further study limitations are that our analysis of visual impairment was based on visual acuity alone, as visual field was not assessed. Due to the study's cross-sectional design, we were unable to determine causal relationships. Accurate subjective assessment of visual acuity was challenging in this vulnerable population due to dementia and other diseases restricting cognitive function and communication. Similar experiences with difficult examination conditions were also described in other studies [2–4].

In conclusion, we found a high proportion of blindness and moderate to severe visual impairment amongst nursing home residents in Germany. Blindness and visual impairment increased with age, reduced mobility and increased need for assistance with activities of daily living, likely due to reduced access to ophthalmological care. These factors should be considered when planning a more tailored eye healthcare provision for these hard-to-reach populations in need in the future.

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Compliance with ethical standards

Disclosure of potential conflicts of interest S. Thiele reports personal fees from Carl Zeiss MediTec, Heidelberg Engineering, and Optos, outside the submitted work. T. U. Krohne reports personal fees from Alimera Sciences, Bayer, Heidelberg Engineering, and Novartis, outside the submitted work. F. Ziemssen has received honoraria for consultation and research from Alimera, Allergan, Bayer, Biogen, MSD, Novartis, NovoNordisk and Roche, none was related to the topic. F.G. Holz reports personal fees from Acucela, Allergan, Bayer, Bioeq, Boehringer Ingelheim, Carl Zeiss MediTec, Genentech/Roche, Heidelberg Engineering, Merz, NightstarX, Novartis, Optos, Pixium and Thea, outside the submitted work. R. P. Finger reports personal fees from Bayer, Opthea, Santen, Novartis, Retina Implant and Novelion, outside the submitted work.

None of the sponsors had any role in the study design; in the collection, analysis and interpretation of the data; in the writing of the report; and in the decision to submit the paper for publication. None of the authors has any proprietary or competing interests to disclose.

Research involving human participants All procedures performed in studies involving human participants were in accordance with the ethical standards of the local ethic committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants or their legal guardians included in the study.

Appendix

Contributing Centers and Members Participating in the OVIS Study

- Department of Ophthalmology, University of Frankfurt, Germany: Prof. Dr. Thomas Kohnen, Dr. Lubka Naycheva, Maximilian Jochem
- Department of Ophthalmology, University of Freiburg, Germany: Prof. Dr. Thomas Reinhard, Prof. Dr. Daniel Böhringer, Dr. Diana Engesser, Prof. Dr. Wolf Lagrèze, Claudia Müller, Carolin Wolff, Jessica Schmitz

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