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Blindness Incidence in Germany

A Population-Based Study from Württemberg-Hohenzollern

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Key Words
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Abstract
Few data on the incidence of blindness in Germany are available. We analysed causes of legal blindness for the region Württemberg-Hohenzollern (population 5.5 million) in order to help fill in this gap. ***Material and Methods:*** Population-based investigation on the incidence of legal blindness (visual acuity <1/50) based on materials from the social servies. Age-dependent blindness incidences were modelled via logistic regression models. ***Results:*** 647 blind persons were newly registered in 1994 (blindness incidence 11.6/100,000). The blindness incidence is moderate in infants (4.5/100,000) and decreases further during childhood. At the age of 20 years, the incidence again rises to the former level and remains relatively constant. After the age of 60 years, the incidence increases sharply: 5-year odds ratios are 1.76 (CI: 1.68–1.85) in women and 1.72 (CI: 1.60–1.84) in men. The blindness incidence is higher in women, 15.6/100,000, compared to 12.2/100,000 in men. The major causes of blindness are: macular degeneration, 3.92/100,000; diabetic retinopathy, 2.01/100,000; glaucoma, 1.6/100,000; high myopia, 0.77/100,000; optic atrophy, 0.68/100,000; central nervous system-triggered blindness; 0.56/100,000, and tapetoretinal degenerations, 0.52/100,000. ***Discussion:*** Due to monetary incentives for the blind persons, social service files offer accurate and complete data. Besides macular degeneration, glaucoma and diabetic retinopathy are major causes of blindness. Thus, this study suggests further blindness prevention activities for diabetic retinopathy and glaucoma.

Introduction

Blindness causes human suffering and high social costs: over 1.2 billion DM blindness compensation payments are spent annually nation-wide in Germany for the 112,000 blind citizens [1]. Few data on the incidence of blindness in Germany are available. Such data are useful for estimating the needs for medical care, counselling, preventive and rehabilitative measures. Virtually all blind persons are registered with the social services. Thus, we analysed data from these institutions with regard to age-, sex-, and cause-specific blindness incidence in order to help in (long-term) planning for the prevention of blindness.

Methods

Materials

This study was planned as a population-based investigation on the incidence of blindness. It analysed materials from the social serivces of the region Württemberg-Hohenzollern, Germany. The social services cover a population of 5.5 million inhabitants. Files from all

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Table 1. Coding of causes of blindness

Cause of blindness	Included diagnostic categories	Excluded diagnostic categories
Retinal detachment	Unspecified or traumatic	Secondary cause (e.g. due to diabetic retinopathy or high myopia)
Catarct	Unspecified, congenital, traumatic	Secondary cause (e.g. due to tapeto-retinal degeneration)
Chorioretinitis	Unspecified, choroideremia	
Encephalomyelitis disseminata	Neuritis nervi optici	
Glaucoma	Unspecified, congenital, narrow-angle, normal-tension glaucoma	Secondary glaucoma (e.g. due to trauma or diabetic retinopathy)
Corneal opacification	Unspecified, traumatic	Secondary (e.g. due to multiple glaucoma operations)
Iritis/uveitis	Unspecified	Secondary (e.g. due to diabetic retinopathy)
Macular degeneration	Unspecified, Junius Kuhnt, juvenile	Secondary (e.g. due to high myopia, diabetic retinopathy)
Malformations	Bulbs, papilla	Head and brain
High myopia	All sequelae of high myopia: retinal detachment, fundal changes	
Optic atrophy	Leber's atrophy, Behr's atrophy, traumatic, vascular	Secondary (e.g. due to glaucoma, brain injuries)
Diabetic retinopathy	All sequelae of diabetic eye disease: detachment, proliferation, secondary glaucoma, vitreous haemorrhage	
Retinopathy of prematurity	Unspecified, retrolental fibroplasia	
Tapetoretinal degeneration	All forms	
Central nervous-system-triggered blindness	Due to head tumours (also if surgically removed), stroke, brain injuries, brain hypoxia	
Vascular occlusions of the eye	Central artery occlusion, central venous thrombosis, arteritis temporalis	
Others	Unspecified bulbus haemorrhage, infections of the vitreous, unspecified phthisis, eye tumours	

subjects that have been newly granted blindness compensation payments in Württemberg-Hohenzollern in 1994 have been included. According to the German legal definition of blindness, subjects applying for compensation payments must have a visual acuity of equal or less than 1/50, or a visual impairment that is comparable to visual acuity 1/50 (e.g. visual fields constricted to 5° irrespective of visual acuity). For the latter cases, criteria of the German Ophthalmologic Society are applied [2].

Ophthalmologic expertises are required by the social services for granting social support. These were worked out by consultant ophthalmologists in private offices (90.7%) or hospital departments (9.3%). Data were recorded from copies of the original paper files. Complying with German data protection laws, the names, dates of birth and addresses of the blind subjects had previously been erased from the copies. Instead, sex, year of birth and home region of the blind individual were noted on the copy by the social services' staff.

Information on ocular status (findings, diagnosis, visual fields if visual acuity >1/50) and prognosis with regard to vision were extracted from the files.

Definitions

The cause of blindness was determined starting from the information given in the ophthalmologic expertises. If more than one disease was responsible for the visual loss, the cause of blindness was defined according to the following criteria:

- the disease that was responsible for the severer ocular pathology (e.g. macular degeneration if cataract and macular degeneration were given);
- the disease that impaired vision in the least seeing eye (e.g. glaucoma if amaurosis by trauma and glaucoma were given);
- the disease that had impaired vision more recently (e.g. vascular occlusion if glaucoma and central retinal artery occlusion were given).

Coding of Causes of Blindness

Causes of blindness were classified according to clinical terminology (table 1). This was done so because the materials that form the basis for this investigation used the clinical terminology.

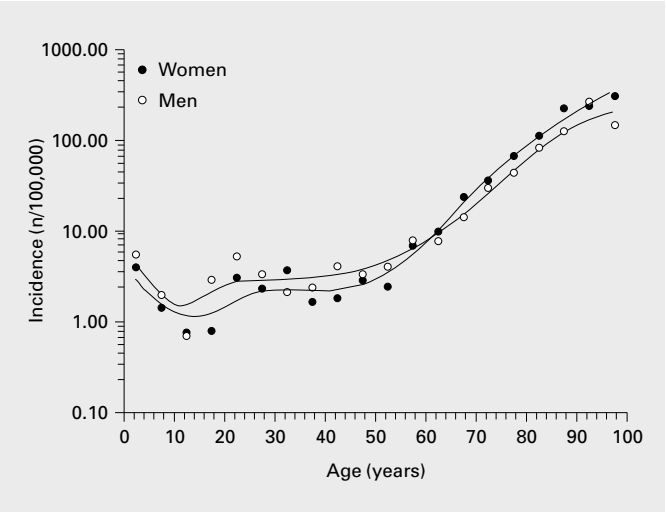

Fig. 1. Blindness incidence in Württemberg-Hohenzollern according to age and sex groups.

Table 2. Population-based blindness incidence (per 100,000) in Württemberg-Hohenzollern 1994

Age years	Blind		Blindness incidence per 100,000		
	male	female	male	female	population
1–4	9	6	5.3	3.7	4.5
5–9	3	2	1.8	1.3	1.6
10–14	1	1	0.6	0.7	0.7
15–19	4	1	2.7	0.7	1.7
20–24	9	5	4.8	2.8	3.8
25–29	8	5	3.1	2.1	2.6
30–34	5	8	1.9	3.4	2.6
35–39	5	3	2.3	1.5	1.9
40–44	7	3	3.7	1.6	2.7
45–49	5	4	3.0	2.5	2.8
50–54	7	4	3.7	2.2	2.9
55–59	14	12	7.3	6.4	6.8
60–64	10	13	7.2	9.2	8.2
65–69	15	31	13.4	22.6	18.5
70–74	22	47	28.7	34.3	32.3
75–79	16	50	42.2	65.0	57.4
80–84	31	99	78.7	111.1	101.2
85–89	22	104	125.0	224.7	197.3
90–94	12	34	262.2	237.9	243.8
⩾95	1	9	144.9	315.2	282.1
Total	206	441			

Data Handling and Statistical Analysis

All data were recorded and processed in LARS, an information processing software system [3]. All statistical analyses were done with the statistical software package SAS [4].

Age-dependent blindness incidences were modelled via two separate sex-specific logistic regression models [5]. Each model fits a piecewise linear function, the change points were determined by the ages of 15, 25 and 55 years, respectively. The results are presented by 5-year odds ratios and their respective 95% confidence intervals (CI). Each odds ratio may be interpreted as the risk for blindness of a person with a determined age contrasted with the risk of the same persons with an age of 5 years less.

Indirect standardisation [6] was used to compare women and men (standardisation with respect to age distribution) and the study population with external populations (standardisation with respect to age and sex distribution where possible).

Results

At the fixing date (October 4, 1994), 5,356 blind persons were registered with the social serives in Württemberg-Hohenzollern. Given a population of 5.5 million, the blindness prevalence was 96/100,000. The sex-specific prevalence was 76.7 in men and 115.4 per 100,000 in women.

In 1994, the number of the newly registered blind persons totalled 647 (table 2). This results in a blindness incidence of 11.6/100.000. On the basis of the total German population for 1994 [7], we estimate a blindness incidence of 11.3 (standardised for age and sex). This results in an estimated 9,451 newly blind persons each year for Germany. The blindness incidence is moderate in infants (4.5/100,000) and decreases during childhood (fig. 1). Logistic regression reveals for this period a 5-year odds ratio of 0.50 (CI: 0.24–1.02) in girls and 0.64 (CI: 0.38–1.07) in boys. In total, children under 10 years accounted for 3.1% of cases. At the age of 20 years, the incidence again rises to the former level. This rise entails 5-year odds ratio of 1.78 (CI: 0.80–3.99) in women and 1.43 (CI: 0.80–2.57) in men. Next, the incidence remains relatively constant for the next 30 years yielding 5-year odds ratios of 1.16 (CI: 1.04–1.30) in women and 1.05 (CI: 0.94–1.17) in men. After the age of 60 years, the incidence increases sharply. Here, the 5-year odds ratios are 1.76 (CI: 1.68–1.85) in women and 1.72 (CI: 1.60–1.84) in men. Consequently, one fifth of cases are subjects in the working age (15–65 years), but about half (48.2%) of the newly blind persons are over 80 years of age. Moreover, nearly 10% of newly blind persons are 90 years and older.

Two out of 3 (68.1%) newly blind subjects are women. After indirect standardisation for the women's age distribution [pers. commun., Statistical Office of Baden-Württemberg], it generally turns out that the blindness inci-

dence is higher in women (15.6/100,000) compared to men (12.2/100,000). The incidence ratio between women and men is 1.28. However, before the age of 60 years, the blindness rate is higher in the male population yielding an incidence ratio of 0.74. In contrast, after the age of 60 years, the female/male ratio switches to 1.43.

Residual Visual Acuity in Blind People

Only a small minority (6.3%) of blind persons have no residual vision (table 3). However, the majority (70%) of blind subjects retain a visual acuity of 0.02 or less. In one fifth of the blind, the visual acuity ranges from 0.02 to 0.3. In a small number of cases, the central vision exceeded 0.3 (1.1%). These persons were considered blind due to extensive visual field loss.

Causes of Blindness

The distribution of causes of blindness in Württemberg-Hohenzollern is shown in table 4. The three most frequent causes of blindness are: macular degeneration (incidence 3.92/100,000), diabetic retinopathy (incidence 2.01/100,000) and glaucoma (incidence 1.6/100,000). Nearly two thirds of all newly blind individuals lost sight due to these three disease groups. High myopia (0.77/100,000), optic atrophy (0.68/100,000), central-nervous-system-triggered blindness (0.56/100,000) and tapetoretinal degenerations (0.52/100,000) cause roughly one fifth of cases. A large spectrum of other diseases is responsible for the remaining small proportion of new cases of blindness: malformations, corneal opacification, cataract, vascular diseases of the eyes, retinal detachment and retinopathy of prematurity.

Causes of Blindness According to Age Groups

Only a small number of children (age <15 years) turned blind (incidence 2.3/100,000). In this age category the most frequent cause is central-nervous-system-triggered blindness (table 5). Retinopathy of prematurity and optic atrophy still play a significant role.

In younger adults (age category 15–44 years) there is a wide spectrum of diseases leading to blindness. The most frequent cause is tapetoretinal degeneration (incidence 0.69/100,000). Four diseases (central-nervous-system-triggered blindness, malformations, diabetic retinopathy, optic atrophy) have a similar frequency (incidence 0.24–0.28/100,000 of the population) in the newly blind population of WH.

In older adults (age category 45–74 years), diabetic retinopathy is the leading cause of blindness affecting more than one third of cases (3.74/100,000). Macular degeneration is the cause of blindness for nearly one fifth of cases (1.92/100,000). Thus, these two diseases are responsible for more than half of all cases. Myopia, glaucoma, tapetoretinal degeneration, optic atrophy and central-nervous-system-triggered blindness number similarly in this age group (5–7%). All other blinding diseases are less common.

In old persons (age >74 years), the leading cause of blindness is macular degeneration affecting nearly half of all newly blind (incidence 54.3/100,000 of the population). One fifth of all cases lost vision due to glaucoma (incidence 22.8/100,000). Every tenth blind individual in this age group lost vision due to diabetic retinopathy. All

Table 3. Residual visual acuity in blind subjects

Visual acuity	Cases	Percentage
Amaurosis	41	6.3
<0.01	123	19.0
0.01–0.02	330	51.0
0.021–0.05	91	14.1
0.051–0.3	46	7.1
>0.3	7	1.1
?	9	1.3
Total	647	

Table 4. Causes of blindness in Württemberg-Hohenzollern

Cause of blindness	Cases	Incidence per 100,000
Macular degeneration	218	3.92
Diabetic retinopathy	112	2.01
Glaucoma	89	1.60
High myopia	43	0.77
Optic atrophy	38	0.68
Central-nervous-system triggered	31	0.56
Tapetoretinal degeneration	29	0.52
Malformations of the eye	14	0.25
Corneal opacification	13	0.25
Cataract	11	0.20
Vascular occlusions of the eye	10	0.18
Retinal detachment	7	0.13
Chorioretinitis and choroideremia	7	0.13
Retinopathy of prematurity	7	0.13
Iritis and uveitis	5	0.09
Encephalomyelitis and neuritis nervi optici	4	0.07
Other	5	0.09
?	4	0.07
Total	647	

Table 5. Causes of blindness according to age group

Cause of blindness	Age <15 years		Age 15–44 years		15–74 years		Age >74 years	
	cases	incidence	cases	incidence	cases	incidence	cases	incidence
Cataract			2	0.08			8	2.42
Central-nervous-system triggered	9	0.94	7	0.28	10	0.55	5	1.52
Choroideremia chorioretinitis			2	0.08	3	0.16	2	0.61
Corneal opacification					4	0.22	8	2.42
Diabetic retinopathy			6	0.24	68	3.74	38	11.53
Glaucoma					12	0.66	75	22.75
Glaucoma, congenital			2	0.08				
Iritis/uveitis					3	0.16	2	0.61
Macular degeneration					35	1.92	179	54.29
Macular degeneration, juvenile			3	0.12				
Malformations	2	0.21	7	0.28	4	0.22		
Myopia			3	0.12	13	0.71	26	7.88
Ocular vessel occlusion					2	0.11	8	2.42
Optic atrophy	4	0.42	6	0.24	10	0.55	18	5.46
Optic neuritis/multiple sclerosis			2	0.08	2	0.11		
Retinal detachment					3	0.16	3	0.91
Retinopathy of prematurity	5	0.52	2	0.08				
Tapetoretinal degeneration			17	0.69	11	0.60		
Others	2	0.21	4	0.16	3	0.16	3	0.91
Unknown					1	0.05	3	0.91
Total	22		23		184		378	

Incidence calculated per 100,000.

other causes of blindness account for roughly one fifth of cases. In this age group no cause of blindness could be determined for 3 cases.

Age at Onset of Blindness in Regard to Cause of Blindness

The distribution of age of onset of glaucomatous blindness (excluding congenital glaucoma) is shown in table 6. Virtually all blind persons with glaucoma lost sight after the age of 65 years. The majority (approx. 75%) turned blind in the age range of 75–89 years.

Macular degeneration (excluding juvenile forms) causes blindness predominantly in late life. More than 70% of newly blind persons due to these diseases are 80 years of age and older (table 6). Only few cases occur before the age of 65 years.

Subjects that lost sight due to diabetic retinopathy do so at a younger age. Most newly diabetic blind people are 55–79 years of age. In our data 2 cases turned blind before the age of 30 years. Subjects older than 80 years present a minority in the diabetic blind. All new diabetic blind persons above this age (>80) in this study were female.

Residual Visual Acuity with Regard to Main Cause of Blindness

The residual visual acuity for the three main causes of blindness is shown in table 7. In the blind group with glaucoma more cases of amaurosis and visual acuity <0.01 are present, but also more persons with visual acuity better than 0.05 (1/20). In the macular degeneration group more than two thirds of cases had a residual visual acuity of 0.01–0.02.

Discussion

In Germany blind citizens are entitled to a monthly monetary support (independently of other revenues). As had been shown [8, 9], monetary support for blind persons (as this is the case for the UK and Germany) is related to accurate and complete registry data. In contrast, membership in associations for the blind does not provide complete data [10]: only one third of the blind subjects registered with the social services are also members of the German Association for the Blind. Especially those blind

Table 6. Blindness incidence according to major causes, age and sex

Age years	Macular degeneration				Glaucoma				Diabetic retinopathy			
	cases		incidence		cases		incidence		cases		incidence	
	m	f	m	f	m	f	m	f	m	f	m	f
<65	1	7	0.04	0.30	1	1	0.04	0.04	14	13	0.57	0.56
65–69	3	4	2.68	2.91	3	3	2.69	2.19	6	19	5.37	13.85
70–74	3	18	3.91	13.13	3	1	3.91	0.73	6	20	7.82	14.59
75–79	5	14	13.19	18.19	7	12	18.46	15.59	3	14	7.91	18.19
80–84	17	50	43.14	56.13	3	18	7.61	20.20		8		8.98
85–89	12	51	68.17	110.21	6	18	34.08	38.90		7		15.12
90+	6	23	113.91	134.16	4	6	75.94	34.00		2		11.67
Total	47	167			27	59			29	83		

m = Male; f = female.

persons who lost sight in old age or suffer from multiple morbidity are not adequately represented. Self-selected populations in epidemiological field studies may have a similar bias. Thus, analysing data from the social services gives a complete picture of blindness in Germany. However, the depth of information is restricted. The social services must limit their data/information demand to facts needed for checking whether persons applying for blindness compensation fulfil the legal definition of blindness: visual acuity less than 1/50 or other ocular conditions leading to similar decreased visual capacity.

ICD coding as recommended by Thylefors et al. [11] has not been performed. The coding of causes of blindness used clinical terminology to be comparable to recent studies on incidence (and prevalence) of blindness [8, 12–14].

Statistics on the incidence of legal blindness in industrialised countries are sparse. More recent statistics are from the UK [13, 15, 16]. In the UK a system of social support for the blind has been introduced in 1948 (to some extent comparable to that of Germany). To achieve monetary benefits blind persons must obtain a certificate of blind registration from a consultant ophthalmologist. However, the incidence of legal blindness is dependent on the visual loss specified in the definition. With regard to World Health Organisation [17] criteria, the German definition of blindness would best match category 4 (vision <1/50), whereas the British definition would match category 3 (vision <1/20). Expectedly after indirect standardisation to the population of Avon the incidence of legal blindness is much lower in Württemberg-Hohenzollern than in Avon: 12.0/100,000 compared to 30.6/100,000 [13] (population data provided by the Office for National Statistics [pers. commun.]. Similar to studies from the UK, the incidence of blindness in Germany is higher in females than in males [13, 16, 18]. Female sex and higher age have also been described as predictors for poor visual acuity in the Beaver Dam Eye Study [19].

Table 7. Residual visual acuity in regard to cause of blindness

Visual acuity	Macular degeneration, %	Glaucoma %	Diabetic retinopathy, %
Amaurosis	1.9	4.6	2.7
<0.01	16.4	24.4	22.3
0.01–0.02	68.2	39.5	48.2
0.021–0.05	13.1	9.3	22.3
0.051–0.3	0.5	18.6	4.5
>0.3	0	2.3	0
?	0	1.2	0

The population is ageing rapidly in industrialised countries and thus blindness incidence and prevalence will increase further [20]. An increasing prevalence of blindness in Germany has been shown in a previous study [21].

Causes of blindness have been investigated starting from registries of the social services [13, 16, 18]. Due to already mentioned differences in blindness definition some causes of blindness have a higher incidence in Avon as compared to Germany (table 8). As the Avon study did not provide sex-specific incidence rates, these comparisons lack the respective standardisation. Given these restrictions, blindness registration due to macular degen-

Table 8. Rates of registration of blind persons per 100,000 population for common disorders: comparison of Avon 1985–1986 (AV) [13] with Württemberg-Hohenzollern 1994 (WH)

	Age 50–59 years		Age 60–69 years		Age >70 years		All ages	
	AV	WH	AV	WH	AV	WH	AV	WH
Macular degeneration	–	0.43	4.9	1.66	128.0	25.11	15.0	3.92
Diabetic retinopathy	0.5	1.58	9.5	4.00	5.2	7.70	1.9	2.01
Glaucoma	–	0.14	2.8	1.06	37.0	9.84	4.7	1.60
High myopia	0.7	0.72	0.8	0.76	10.1	3.66	1.3	0.77
Cataract	–	–	0.3	–	5.0	1.14	0.6	0.20

eration is nearly 4 times more common in the UK than in Germany.

In general, the relative distribution of causes in different other regions is similar to the study area (Bavaria, Germany [22]; Avon, UK [13]; Bradford, UK [15]; Scotland, UK [16]): macular degeneration is the most frequent cause of blindness affecting at least 30% of newly blind subjects. Glaucoma, high myopia and optic atrophy have similar relative frequencies (10–15%). However, these comparisons have not been standardised (e.g. with respect to sex or age).

Conclusions

Blindness incidence and prevalence will increase further. The most frequent cause of blindness is macular degeneration, though, put together, diabetic retinopathy and glaucoma have a similar incidence. For the latter, blindness prevention is conceivable. Thus, the results of this study point to the initiation of co-ordinated activities to prevent blindness for diabetic retinopathy and glaucoma.

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