

Prevalence and causes of visual impairment in Swedish individuals 65–74 years of age.

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1 Summary in Swedish for general audiences (Populärvetenskaplig sammanfattning)

I denna studie beskrivs förekomsten (prevalensen) av, och orsaker till, synnedsättning och blindhet på ett eller båda ögonen. Uppgifter insamlade 1984–86 i Tierps kommun, Uppsala län, för att studera förekomsten av grön starr (glaukom, en ögonsjukdom) har använts för detta. 838 personer i åldersgruppen 65–74 år erbjöds delta, och 755 (90%) genomgick fullständiga underökningar och ingår i studien. Något fler av dessa var kvinnor och unga. Uppgifter om bland annat synskärpa, synfält och orsaken till eventuell synnedsättning finns angivet.

Bara en person var blind på båda ögonen, och fem ytterligare personer hade nedsatt syn, varför också förekomsten av blindhet eller nedsatt syn på minst ett öga undersöktes. 31 personer var då blinda, och 38 hade nedsatt syn, vilket motsvarar ungefär fyra respektive fem procent.

Den vanligaste orsaken, motsvarande 1/3 av fallen, till nedsatt syn eller blindhet på ett öga var grå starr (katarakt), en vanlig åldersrelaterad ögonsjukdom där ögats lins grumlas. Amblyopi, ett tillstånd där synen på ett öga aldrig utvecklats, ofta till följd av brytningsfel, var näst vanligast. Andra vanliga orsaker var grön starr (glaukom: skada på synnerven, ofta på grund av förhöjt ögontryck), åldersförändringar i gula fläcken (makuladegeneration) och skador på ögat till följd av diabetes.

Synnedsättning var, som förväntat, vanligare i den äldre gruppen. I vissa studier är kvinnligt kön kopplat till ökad förekomst av synnedsättning, men så var inte fallet i denna studie.

Avslutningsvis bör poängteras att deltagarna undersöktes för över 30 år sedan, varför resultaten inte nödvändigtvis speglar dagens situation, och att personer 75 år och äldre inte undersöktes.

2 Abstract

Purpose: To study the prevalence and causes of visual impairment (VI) in a population of Swedish adults aged 65–74 years.

Methods: Data collected in 1984–86 as part of the *Tierp Glaucoma Survey* was analysed. It contains information on visual acuity and causes of VI or blindness in 755 subjects (90% of the 838 eligible), stratified by gender and age group (65–69 and 70–74). More people in the sample were women and younger than 70 years. Visual acuity was measured with a Snellen chart at 5 meters, and visual fields with automatic perimetry. World Health Organization (WHO) and United States (US) criteria for blindness and VI were used.

Results: Using WHO criteria, 1 individual was bilaterally blind, and 5 individuals had bilateral VI. Thirty-one individuals, 4.1% (95% confidence interval (CI): 2.9–5.8), were blind in at least one eye, and 38, 5.0% (95% CI: 3.7–6.8), were visually impaired. Cataract, amblyopia, glaucoma, macular degeneration and diabetes were, in order, the leading causes of monocular VI or blindness. Using the US criteria, 4 individuals were blind and 19 visually impaired.

Conclusions: Cataract accounted for 1/3 of monocular VI. Age, but not gender, was significantly associated with monocular VI.

3 Background

Blindness and visual impairment affect a large number of individuals. Globally, an estimated 440 million people, out of a total population of 7.33 billion (giving a prevalence of about 6%), had some form of visual impairment (mild to severe) or blindness, according to the criteria set by the World Health Organisation (see 3.1.1). Of these 440 million, 36 million were thought to be blind (0.48%) (1). A plethora of studies have shown that the prevalence of visual impairment and blindness increase with increasing age (2–13). The overall global prevalence of visual impairment is therefore increasing as the population grows older, but the age-adjusted prevalence has instead decreased with nearly 40% since 1990 (1). In a study of high income European countries, the prevalence of blindness decreased with 50% from 1990 to 2010, and the prevalence of moderate to severe visual impairment with about 40% (14).

3.1 Definitions of visual impairment and blindness

Two definitions of blindness and visual impairment are predominantly used: those by the World Health Organization (WHO) and those by the United States legislature. Both definitions include the visual field as a parameter for blindness, but not all studies use this part of the definition.

3.1.1 World Health Organization definition

In the 10th revision of the International Classification of Disease (ICD-10) by the WHO (15), visual impairment is defined as best corrected visual acuity (BCVA) ranging from <0.3 to ≥ 0.05 . Blindness is defined as BCVA <0.05 or a visual field of $\leq 10^\circ$ around central fixation. In the case of bilateral visual impairment or blindness, the criteria apply to the better seeing eye, and in the case of monocular disease, the worse eye.

3.1.2 United States definition

The United States definition of visual impairment used by multiple studies is BCVA <0.5 (20/40) to >0.1 (20/200) (5,7). “Legal blindness” is defined in the Code of Federal Regulations as BCVA ≤ 0.1 (20/200) or a visual field of $\leq 20^\circ$ around the point of fixation (16).

3.2 Prevalences of visual impairment and blindness globally

Internationally, several studies have been published on VI in different countries and continents. Direct comparison between studies is in some cases complicated by differences in the age groups included, the definitions used (WHO contra US) and the amount of correction carried out (only presenting VA, pinhole correction or BCVA). But, generally, higher proportions of blindness and visual impairment are reported from developing countries than from developed countries (1,17).

The following sections aim to give a general overview of prevalence estimates from different countries, but one should be aware that the absolute prevalences are uncertain and confidence intervals large. As an illustration, the prevalence of bilateral blindness in Reykjavik (6) among those aged 80 or above has been estimated to 6.58%, with a 95% confidence interval of 0.88–12.28 (a total of 5 cases).

3.2.1 Bilateral blindness

Studies from Ethiopia (18) (Horn of Africa), Malawi (19) (south-eastern Africa) and the Gambia (20) (West Africa) have shown blindness prevalence rates (WHO definition, not accounting for visual fields, correction with pinhole) ranging from 1.3–1.5% at 50-59 years of age to 9.3–17.5% at 70 years and older.

Similar prevalences for blindness have been reported from a large cross-sectional study in Tibet (21), increasing from 1.7% at 50–59 years of age, to 20.8% in those aged 70 and older. Although the same method of correction (pinhole) was used as in the African studies, this study used the broader US definition of blindness.

The blindness rates reported from the United States and western Europe are decidedly lower, although the absolute number of cases are small with often only one to a handful of cases per age category, making the absolute numbers in the population as a whole uncertain.

Using WHO criteria with BCVA, rates ranging from around 0.1% at ages around 60–70 and increasing to about 1.1–1.4% at ages at or above 80 have been reported in multiple studies from the US and western Europe. (7,9,22) Similar rates have been reported from Beijing (10) in mainland China and slightly higher rates were observed in Taiwan (0.2% and 1.7%,

respectively for the age groups (23)). A study from Melbourne, Australia, showed 1.9% at or above the age of 80 to be blind (2).

Higher rates have, however, also been reported. A study from Baltimore showed similar rates in the younger age group, but reported that 4% of whites aged 80 or above were blind (5). In Kentucky the rate was 3.3% (24), and in Reykjavik, Iceland, prevalences as high as 6.6% were found for those aged 80 or above (6). Table 1 shows prevalences of blindness and visual impairment in a selection of countries.

3.2.2 Visual impairment

Reported rates of visual impairment, unsurprisingly, are generally higher than those for blindness. The following paragraphs aim to give some examples of prevalences (according to WHO criteria unless otherwise stated). The age groups differ slightly (e.g. 60–69 or 65–69) between some studies.

From Ethiopia (18) and Malawi (19) prevalences ranging from about 11% at 60–69 to 16–24% in those aged 70 and above have been reported.

European studies show prevalences of 0.5–1.0% at ages around 60 to 70 (6,9,25) (the studies do not stratify by the same age group), increasing to 8–12% at 80–85 or older (6,9).

Studies from the US have shown prevalence rates ranging from 1.4–1.6% at about 60–69 to 6.0–17.3% at those aged 80 and above (5,7,24) (the 6.0% prevalence was measured in a group aged 80–85 (7)). If instead using US criteria, prevalences ranging from 2.1–4.7% at about 60–69 to 15.3–33% at 80 and above (3,5,7,22,26) have been noted.

From mainland China, Taiwan and Singapore prevalences ranging from 0.8–1.8% at about 60–69 to 3.1–5.5 at 0 years or above (5.3% at 80 or above in Taiwan) are reported (10,23,27).

Table 1. Prevalences of bilateral blindness (BCVA <0.05) and visual impairment (BCVA >0.05 – <0.3) according to the WHO definitions, in different age groups in a selection of countries ordered alphabetically by continent.

Study (year published)	Age group (years)	Prevalence	
		Blindness (%)	Visual impairment (%)
Ethiopia (1997) (18)	60–69	8.3	11.3
	≥70	17.5	16.1
Malawi (1986) (19)	60–69	6.0	11.2
	≥70	11.1	24.1
Barbados (2001) (11)	60–69	0.9	4.8
	70–79	4.4	15.2
	≥80	8.9	26.8
Baltimore (1990) (5)	60–69	1.2	1.6
	70–79	0.8	4.1
	≥80	3.6	17.3
Salisbury (1997) (7)	65–69	0.3	1.4
	70–74	0.0	1.0
	80–85	1.1	6.0
Beijing (2006) (10)	60–69	0.3	1.1
	≥70	1.4	5.5
Taiwan (2004) (23)	65–69	0.2	0.8
	70–74	0.4	3.3
	≥80	1.7	8.3
Melbourne (1997) (2)	60–69	0.1	0.5
	70–79	0.0	1.6
	≥80	1.9	4.3
Reykjavik (2008) (6)	60–69	0.0	0.6
	70–79	0.4	0.8
	≥80	6.6	7.9
Rotterdam (1998) (9)	65–74	0.1	0.4
	≥85	3.9	11.8

3.3 Demographic risk factors for visual impairment

As stated previously, a well-documented fact is that visual impairment and blindness become more prevalent with increasing age (1).

Some studies from the US indicate higher prevalences of blindness among black residents than white of similar socioeconomic status and age (5,7).

While the role of gender varies between studies, with some indicating female gender to increase the risk of VI (2–4,7,8,10,21,22), not affect it (5,6,9,12,23,27–29) or lower the risk (11,18,26,30), it is recognized that a majority of those visually impaired or blind are women, also when adjusting for age. Multiple mechanisms have been proposed for this, including estrogen decreasing the risk of cataract, with late menopause or hormonal replacement therapy lowering the risk, and differences in access to, and utilization of, healthcare (31).

3.4 Causes of visual impairment and blindness

Regarding the causes of bilateral visual impairment and blindness, uncorrected refractive error is the leading cause of presenting VI and an important cause of blindness (17).

Excluding these cases (since the definitions are based on best-corrected visual acuity), age related cataract is the most common cause for blindness reported from many countries in Africa (18–20,29) and visual impairment or blindness in Asia (10,12,21,23,30,32). Studies from Europe and Australia have shown age-related macular degeneration (AMD) to be the leading cause of blindness (6,8,9,33), with cataract (8,9,25,33) and glaucoma (8) also being prevalent causes of non-blinding visual impairment in some studies.

A study on Mexican-Americans living in the US found glaucoma to be the leading case of bilateral blindness, followed by cataract, AMD and diabetic retinopathy (34), a surprisingly high prevalence of both glaucoma and diabetic retinopathy compared to other studies, although similar prevalences of glaucoma have been reported from Barbados (11), and similar prevalences of diabetic retinopathy have been reported from Kentucky, US (24).

Other reasons for blindness reported from Africa were corneal scarring (not resulting from trachoma) (18–20) and trachoma (18,20) (an infection by *Chlamydia trachomatis*, common to

some poor communities, resulting in scarring of the upper eye lid with accompanying inversion of the eyelashes and subsequent damaging of the cornea (35)), while such causes were rarely reported from other countries such as Nigeria, where instead glaucoma and AMD were important causes (29).

From Asia, other important causes of blindness include degenerative myopia reported from Beijing and Taiwan (10,23), AMD (21,23,32), glaucoma (10,27) and corneal opacity (21), but the causes varied between different countries in the region.

Amblyopia has in some studies been identified as a cause of monocular visual impairment (6,8,13,24,24,29,32,34).

3.5 Visual impairment in Sweden

To the author's best knowledge, no comprehensive studies have been published on the prevalence and causes of blindness and visual impairment in Sweden.

In a longitudinal study from Gothenburg (28) the prevalence of blindness ranged from 1.4% at 70 years of age, to 27% at 97.

The Skövde Cataract Study reported the mean visual acuity (VA) for the right eye for men and women aged 70–94, which showed women to have worse mean VA than men (36). Neither study reported the causes of vision impairment.

With regards to a younger population, Hauffman (1974) (37) reported prevalences and causes of visual impairment among adults aged 18–65 in the area around Stockholm, Sweden, and Lindstedt (1969) (38) reported causes of blindness with onset before 60 years of age.

3.6 Aim

In light of the lack of studies on visual impairment in the Swedish population, the aim of this study was to report the prevalence of impaired vision and blindness in one or both eyes, and their respective causes, in a population 65–74 years of age residing in the municipality of Tierp, south-central Sweden.

The following hypothesis were tested with regards to the studied population:

1. Visual impairment and blindness are more prevalent among women than men.
2. Age related macular degeneration is the leading cause of blindness.
3. Prevalences of, and causes for, blindness and visual impairment will differ between the studied population and the population of developing countries.

4 Methods

4.1 Study population

In this cross-sectional study on visual impairment, data from the Tierp Glaucoma Survey (39) was analysed.

The Tierp Glaucoma Survey was carried out during 1984–86 in the municipality of Tierp, north of Uppsala, Sweden, and aimed to describe the prevalence of, and factors increasing the risk for, open angle glaucoma (OAG). For this purpose, individuals aged 65–74 residing in the municipality of Tierp were invited to the study.

A total of 2,377 were eligible for the study. In order to reduce the size of the study population, only those with a date of birth evenly dividable by three were included. The study population was sub-divided into an older group with those aged 70–74 (born 1910–14) and a younger one consisting of subjects aged 65–69 (born 1916–20).

The older age group were examined in 1984–85. The participants invited to this group, 399 in total, were invited to take part via letter, sent out after their birthdate to ensure that they fulfilled the age criteria at the time of examination. Those examined all resided within the municipality of Tierp on the 31st of December 1984.

Similarly, the younger age group were examined in 1985–86. All of them resided within the study area on the 31st of December 1985. Invitations, 439 in total, were sent out in the same way as to the older group.

In total, 755 individuals (90%) were fully examined, of whom 403 (53%) were in the younger age group and 352 (47%) belonged to the older group. The number of female participants were slightly higher than the number of male participants. The fraction of examined participants was somewhat lower among men than females in both age categories, and a slightly lower percentage of subjects were examined in the older group compared to the younger group. Table 2 and Figure 1 provides further information on the participants.

Five individuals could not undergo visual acuity testing but was otherwise fully examined. For the purposes of this study, they are regarded as not having been examined.

Table 2. Participation in the population survey in Tierp by age and gender.

Age group (years)	Females (<i>n</i> = 429)				Males (<i>n</i> = 409)			
	Examined				Examined			
	Yes	(%)	No	(%)	Yes	(%)	No	(%)
65–69	208	(92.9)	16	(7.1)	195	(91.1)	20	(9.3)
70–74	183	(89.3)	22	(10.7)	169	(86.7)	25	(12.9)
All	391	(91.1)	38	(8.9)	364	(89.0)	45	(11.0)

Note that five subjects with unreliable visual acuity testing are considered as not examined.

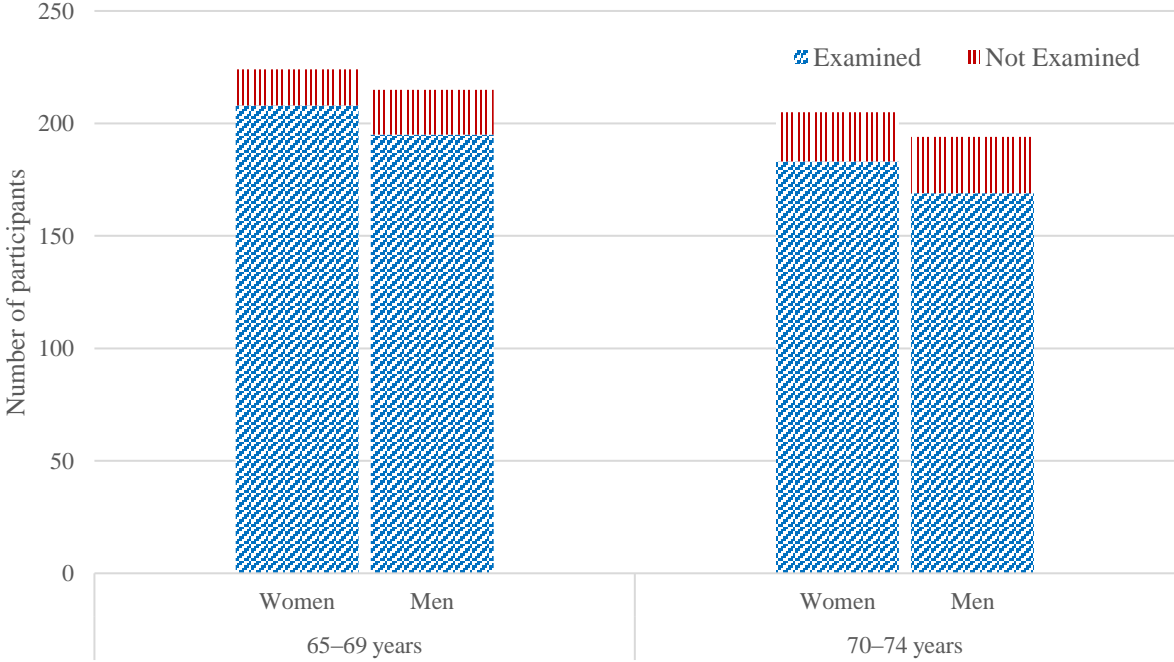


Figure 1. Distribution of participants in the population survey in Tierp by age and gender.

4.2 Examinations

Examinations were undertaken at the Eye clinic in Tierp. The participants underwent a detailed examination including testing of visual acuity, visual fields, measurement of

intraocular pressure (IOP), optic disk imaging, slit lamp examination and gonioscopy, as described in the original publication (39).

Relevant to the present study, participants were questioned about their current eye health, eye symptoms, general health and pre-existing conditions and medication. Information was also collected from medical records.

Distance visual acuity was determined separately for the left and right eye. Presenting visual acuity was determined with the correction habitually worn by the subjects, if any. Best corrected visual acuity (BCVA) was determined using subjective refraction. A wall mounted visual chart of Monoyer type (Ge-Pe chart for 5 meters) with standard lighting (LIC Universal) was used at a distance of 5 meters for this purpose. For each letter, participants were allowed a second attempt at a correct reading if the first had been incorrect. Only one second attempt was granted for every letter, but if all letters on the row was read correctly only on the second try, the row was still accepted as correctly read.

If the visual acuity was less than 0.1 (the first row of letters could not be read correctly), additional testing was carried out. Subjects were first asked to count fingers at a distance 4, 3, 2 and 1 meters and 5 decimetres. If unable, they were asked to localise hand movements and a light source.

Visual field measurements were done for both eyes at 68 points in the central 20° of the visual field using an automatic perimeter, the Competer 350 (Bara Elektronik AB, Lund, Sweden).

Visual field testing and measurement of the ocular pressure was carried out by an assistant. All other examinations were carried out by an ophthalmologist without prior knowledge of IOP or visual fields.

4.3 Definition of visual impairment and blindness

Visual acuity was defined according to WHO definitions (see 3.1.1) Blindness was defined as BCVA <0.05 or a visual field of $\leq 20^\circ$ around the point of fixation and visual impairment as BCVA ≥ 0.05 to <0.3.

To facilitate comparisons with other studies, the United States definition of “legal blindness” (see 3.1.2) (BCVA ≤ 0.1 in the better eye) and visual impairment (BCVA >0.1 to <0.5) was also used. Visual field was not used as a parameter in this case due to limitations in the data.

4.4 Statistical methods

Prevalence rates were calculated with 95% confidence intervals (CI) using the exact method (40) when the number of positive cases were low ($n \leq 20$), and otherwise ($n > 20$) using the Wilson method (41,42). Additionally, differences in prevalence between the genders after adjusting for age with a minimum variance method (43), were estimated.

Odds ratios (OR:s) were calculated to study the effect of age and gender on the risk of visual impairment.

4.5 Ethics committee approval

The original study was approved by the Human Subjects Committee at the Faculty of Medicine at Uppsala University (1983-04-25), and informed consent was obtained from all participants.

5 Results

Bilateral visual impairment and blindness according to the WHO definitions was uncommon in this sample of 755 persons. Only one person, a female in the 65–69 years age category, was bilaterally blind. Cataract was identified as the cause. An additional five individuals were bilaterally visually impaired. For the six eyes where a cause could be determined, cataract, retinal thrombosis and diabetes each accounted for two cases. Table 3 gives further details on the distribution of the cases of blindness and visual impairment.

Table 3. Prevalence (%) of *binocular* blindness, visual impairment, and either visual impairment or blindness, according to WHO-definitions in the Tierp Study, by age and gender.

		Binocular (WHO):					
		Blindness		Visual Impairment		VI or Blindness	
Age (years)	Total no.	<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)
Females							
65–69	208	1	0.5 (0.0–2.7)	1	0.5 (0.0–2.7)	2	1.0 (0.1–3.5)
70–74	183	0	0.0 (–)	1	0.5 (0.0–3.0)	1	0.5 (0.0–3.0)
65–74	391	1	0.3 (0.0–1.4)	2	0.5 (0.1–1.8)	3	0.8 (0.2–2.2)
Males							
65–69	195	0	0.0 (–)	2	1.0 (0.1–3.7)	2	1.0 (0.1–3.7)
70–74	169	0	0.0 (–)	1	0.6 (0.0–3.3)	1	0.6 (0.0–3.3)
65–74	364	0	0.0 (–)	3	0.8 (0.2–2.4)	3	0.8 (0.2–2.4)
Genders combined							
65–69	403	1	0.2 (0.0–1.4)	3	0.7 (0.2–2.2)	4	1.0 (0.3–2.5)
70–74	352	0	0.0 (–)	2	0.6 (0.1–2.1)	2	0.6 (0.1–2.1)
65–74	755	1	0.1 (0.0–0.7)	5	0.7 (0.2–1.5)	6	0.8 (0.3–1.7)

Blindness: BCVA <0.05; VI: BCVA ≥0.05 – <0.3; Blindness or VI: BCVA <0.3.

BCVA: best corrected visual acuity; VI: visual impairment; CI: confidence interval. WHO: World Health Organization.

Using the United States definition of visual impairment and blindness, an additional three cases of blindness and 14 cases of visual impairment could be identified, for a total of 4 and 19 respectively. Table 4 shows the distribution of cases when using the US definitions.

Table 4. Prevalence (%) of *bilateral* blindness, visual impairment, and either visual impairment or blindness, according to the United States definitions in the Tierp Study, by age and gender.

		Binocular (US):					
		Blindness		Visual Impairment		VI or Blindness	
Age (years)	Total no.	<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)
Females							
65–69	208	1	0.5 (0.0–2.7)	3	1.4 (0.3–4.2)	4	1.9 (0.5–4.9)
70–74	183	1	0.5 (0.0–3.0)	5	2.7 (0.9–6.4)	6	3.3 (1.2–7.1)
65–74	391	2	0.5 (0.0–1.8)	8	2.0 (0.9–4.0)	10	2.6 (1.2–4.7)
Males							
65–69	195	2	1.0 (0.1–3.7)	5	2.6 (0.8–6.0)	7	3.6 (1.4–7.4)
70–74	169	0	0.0 (–)	6	3.6 (1.3–7.7)	6	3.6 (1.3–7.7)
65–74	364	2	0.5 (0.1–2.0)	11	3.0 (1.5–5.4)	13	3.6 (1.9–6.1)
Genders combined							
65–69	403	3	0.7 (0.2–2.2)	8	2.0 (0.9–3.9)	11	2.7 (1.4–4.9)
70–74	352	1	0.3 (0.0–1.6)	11	3.1 (1.6–5.6)	12	3.4 (1.8–6.0)
65–74	755	4	0.5 (0.1–1.4)	19	2.5 (1.5–3.9)	23	3.0 (2.0–4.5)

Blindness: BCVA ≤ 0.1 ; VI: BCVA $>0.1 - <0.5$; VI or blindness (BCVA <0.5).

VI: visual impairment; CI: confidence interval; BCVA: best corrected visual acuity;

US: United States.

Table 5. Prevalence (%) of blindness, visual impairment and either visual impairment or blindness *in at least one eye*, according to WHO-definitions in the Tierp Study, by age and gender.

Monocular (WHO): †							
Age (years)	Total no.	Blindness		Visual Impairment		VI or Blindness	
		<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)	<i>n</i>	Prevalence % (95% CI)
Females							
65–69	208	5	2.4 (0.8–5.6)	3	1.4 (0.3–4.2)	8	3.8 (1.7–7.6)
70–74	183	13	7.1 (3.8–12.1)	12	6.6 (3.4–11.5)	24	13.1 (9.0–18.8)
65–74	391	18	4.6 (2.7–7.3)	15	3.8 (2.1–6.3)	32	8.2 (5.9–11.3)
Males							
65–69	195	6	3.1 (1.1–6.7)	11	5.6 (2.8–10.1)	16	8.2 (4.7–13.3)
70–74	169	7	4.1 (1.7–8.5)	12	7.1 (3.7–12.4)	19	11.2 (6.8–17.6)
65–74	364	13	3.6 (1.9–6.1)	23	6.3 (4.2–9.3)	35	9.6 (7.0–13.1)
Genders combined							
65–69	403	11	2.8 (1.4–4.9)	14	3.5 (1.9–5.8)	24	6.0 (4.0–8.7)
70–74	352	20	5.7 (3.5–8.8)	24	6.8 (4.6–9.9)	43	12.2 (9.2–16.1)
65–74	755	31	4.1 (2.9–5.8)	38	5.0 (3.7–6.8)	67	8.9 (7.0–11.1)

Age-adjusted difference in prevalence: males-females = 1.4% (95% CI: -4.4–7.2).

† Two individuals were blind in one eye, and visually impaired in the other.

Blindness: BCVA <0.05; VI: BCVA ≥0.05 – <0.3; VI or blindness: BCVA <0.3.

BCVA: best corrected visual acuity. VI: visual impairment; CI: confidence interval. WHO: World Health Organization.

Table 6. Odds ratios for visual impairment in either eye by age and gender in the Tierp Study.

Age	Male		Female	
	OR	95% CI	OR	95% CI
70–74	3.17	1.35–7.43	3.77	1.65–8.63
65–69	2.23	0.93–5.35	1.00 *	–

* Reference group; Visual impairment: best corrected visual acuity <0.3; OR: odds ratio; CI: confidence interval.

Expanding the group to all individuals with visual impairment or blindness (WHO definition) in at least one eye, 67 cases could be identified (Table 5). Almost 2/3 of them belonged to the older age group. When adjusting for age, the prevalence of visual impairment appeared to be higher among men than women, but this was far from significant as the confidence intervals were very large (end of Table 5).

Odds ratios (Table 6) for any form of visual impairment (defined as visual impairment or blindness in at least one eye according to WHO-definitions) showed that the younger group of females had the lowest risk of visual impairment, and that the effect of gender appeared to differ depending of age group. In the younger group, male gender suggested an increased risk, while the opposite was true in the older age group, where females had a higher risk of any visual impairment than men, suggesting an interaction between age and gender. The total number of cases was, however, relatively small at 67. Because of these indications of an interaction between age and gender, multivariate logistic regression was of limited value.

Cataract was the leading cause of visual impairment (BCVA <0.3) both when considering only the worst seeing eye (Figure 2) and when considering the total number of eyes with impaired vision (Figure 3). Amblyopia was the second most common cause, followed by diabetes, glaucoma and macular degeneration. Two patients had retinal thrombosis as a cause in the better seeing eye. In the remaining eyes, various other causes were identified.

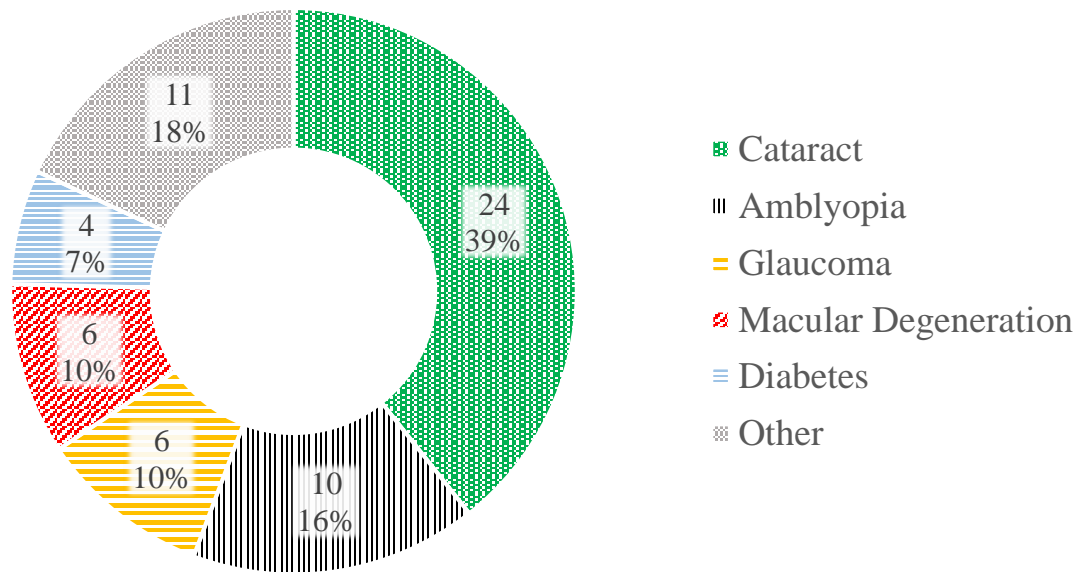


Figure 2. Cause of monocular visual impairment or blindness (BCVA <0.3) in the worst seeing eye of 61 persons in the population survey in Tierp. Those with visual impairment in both eyes ($n = 6$) are not included.

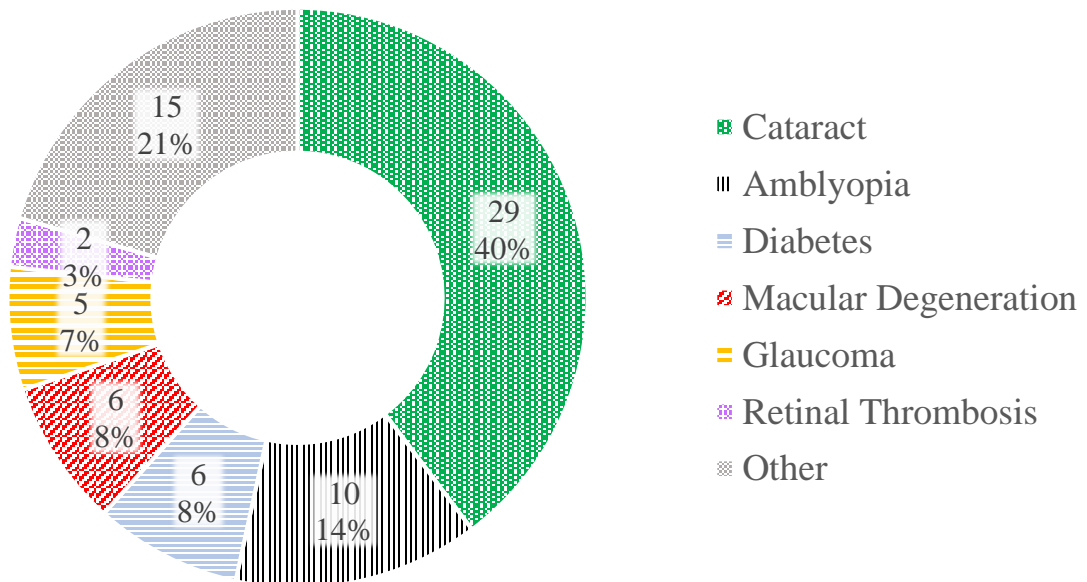


Figure 3. Causes of visual impairment or blindness (BCVA <0.3) in 73 eyes (67 persons) in the population survey in Tierp.

6 Discussion

In this study of the 1984–86 cohort of the population survey in Tierp, prevalences, and causes of, visual impairment in 60–69 and 70–74 years old males and females was determined.

6.1 Prevalences of visual impairment

It is a well-documented fact that the prevalence of visual impairment and blindness is strongly associated with older age (Table 1 shows prevalences of visual impairment and blindness by age group in a selection of ten studies from different countries).

Multiple studies from Europe (6,9), the US (7) and Australia (2) show prevalences of visual impairment ranging from zero to below two percent in patients younger than 80 years old, and while the decrease in prevalence seen in both high income European countries (14) and the world as a whole (1) during recent decades suggest that higher rates of visual impairment could be expected in the older Tierp survey compared to more recent studies, the expected prevalences are probably still in the low single digits for those aged below 80 years of age.

This low expected prevalence, in combination with the relatively small sample size (755 individuals underwent complete ophthalmological examinations), results in a low number of expected positive cases, and subsequently makes statistical analyses difficult, a problem shared with many studies of this kind (2,4,6,7,9,10,19,23).

Given this limitation, great care should be taken when interpreting the prevalences of visual impairment and blindness in this study. As seen in Table 3, only one person was bilaterally blind using WHO definitions, and only six cases of bilateral blindness or visual impairment was identified. This gives a prevalence of bilateral visual impairment of 0.8% (95% CI: 0.3–1.7) for the 65–74 age group, which would be higher than the rates reported from the more recent studies from Reykjavik (6) and Rotterdam (9), close to the prevalence rates reported from recent studies from Beijing (10), Taiwan (23) and Salisbury (7), and decidedly lower than the ten times higher prevalence rates reported from less industrialized countries such as Ethiopia (18), Malawi (19) and Barbados (11). Considering this, the obtained prevalence seems probable, but the low number of positive cases remains a significant limitation.

6.2 Causes of visual impairment

While AMD have been reported as the most important cause of bilateral visual impairment or blindness in multiple studies from Europe and Australia (6,8,9,33), this is not directly comparable with this study, which (due to the low number of cases of bilateral impairment) report causes of monocular blindness (Figure 2), and also examined a younger population.

In the Rotterdam study (9) (conducted 1990–93), only one out of 22 cases of monocular visual impairment in those younger than 75 were due to AMD. Cataract (36% of cases), alone or in combination with another cause, and myopic degeneration were instead common causes in this age group. In the Reykjavik study (6) (1996), amblyopia accounted for 60% of monocular visual impairment in those aged 50–74, with cataract accounting for 25%.

Compared to these studies, the 39% of cases attributable to cataract in this study is higher than in Reykjavik (25%), but comparable to the prevalence in Rotterdam (36%). The incidence of cataract surgery has increased rapidly during the last decades: in Sweden, it doubled between 1992 and 2009 (44), and an American study estimated a five-fold increase from 1980 to 2004 (45). Since the population survey in Tierp was conducted in 1984–86, the Rotterdam study in 1990–93 and the Reykjavik study in 1996, this increase in cataract surgery incidence might account for at least some of the difference in prevalence between the studies. Additionally, it highlights the importance of not assuming the causes of visual impairment three decades ago to be entirely representative of today's causes.

The second most common cause of monocular visual impairment was amblyopia (16%). This is similar to the 19% in rural Kentucky (individuals ≥ 40 years old) (24), and 15% in the Australian Blue Mountains study (US definition, individuals ≥ 43 old) (8). In Reykjavik, amblyopia accounted for half of the cases among those aged 50–74. Multiple other studies have shown the prevalence of causes attributable to amblyopia to be below 11% (13,29,32,34). When discussing the importance of amblyopia, the chosen age group is important, as amblyopia is developed during childhood).

Since the 1970s, Swedish children undergo screening to detect, and treat, vision impairment, which has decreased the prevalence of amblyopia (46), and should decrease the importance of amblyopia as a cause of monocular visual impairment in the future.

As implied earlier, the low amount of cases attributable to AMD might, in addition to AMD being less common as a cause for monocular than binocular VI, in part be explained by the relative low age of the group studied (65–74 years old), as studies of AMD have shown the prevalence to rise after 75 years of age, with much lower prevalences at younger ages. (47,48)

6.2.1 Comparison with low-income countries

Multiple observations can be done with regards to the causes of visual impairment in Tierp compared to some low-income countries.

First, the proportion of VI attributable to cataract is much higher in these countries, even when, as in many of these studies, visual impairment in the entire population is included. Since cataract are more common with advancing age, the proportion of visual impairment attributable to cataract would likely have been even higher in these studies, had the causes of reduced vision in the older age group been reported separately.

In Nigeria, 80% of bilateral low vision were due to cataract (29), in The Gambia the same proportion was 67% (20). In those aged 60 or above in rural India, 84% of unilateral vision impairment was attributable to cataract (13).

Other common causes of visual impairment seen in these countries, but not in Tierp, include corneal scarring, from trachoma, and phthisis bulbi (the shrinkage of the eye, secondary to various causes, including trauma and inflammation (49)). Access to eye care, and the prevalence of endemic pathogens causing eye infections, such as *Chlamydia trachomatis*, might be possible contributing factors.

Conversely, other causes common in Tierp that were more uncommon in Ethiopia (18), Nigeria (29), The Gambia (20) and rural India (13), include diabetes, macular degeneration and glaucoma.

6.3 Age and gender

The increased prevalence of visual impairment with advancing age have been well established previously and remains true also for this population.

Gender was not significantly associated with visual impairment (Table 5). Calculations of odds ratios (Table 6) imply that female gender decreased the risk of visual impairment in the younger age group, but not in the older group, suggesting a possible interaction between age and gender. Therefore, the interpretation in the present study is that no significant effect can be seen with regards to gender.

One explanation that could be proposed for this finding is, again, the relatively young population studied. Many cases of visual impairment were due to amblyopia, which is not associated with female gender (50). Meanwhile, cataract is strongly related to increasing age and more common among women (31). In other words, had the examined population been older, it is possible that female gender had been related to VI.

There are, however, conflicting results on the effect of gender in other studies. In the Rotterdam study (9), females had a higher risk of VI in all age groups, but this was not statistically significant. The Reykjavik study (6) reported that gender was not associated with visual impairment in any age group, including the ≥ 80 strata, and the Proyecto VER-study (26) showed that both genders had similar risks of VI at younger ages, but that male gender were associated with higher prevalence of VI in those aged 80 and above. The Blue Mountains study (8) showed females to be at increased risk in all ages, but did not report if the strength of this association varied by age group. The validity of the explanation proposed in the previous paragraph can therefore be questioned.

6.4 Strengths and limitations

The strengths of this study include the high rate of participation (90% of those eligible underwent complete examinations) and the random selection of participants (those with a birthdate evenly dividable by three), which reduces the risk of selection bias. All eye examinations were carried out by the same ophthalmologist following a study protocol.

The largest limitation of this study, with regards to estimating the prevalence and causes of visual impairment in the older population as a whole, is that the age group chosen limit the impact of many age-related causes. Because of this, these results are not directly applicable on the larger population of older adults as a whole.

The number of participants is, in combination with the low prevalences of VI and blindness in the chosen age groups, too small to adequately estimate the prevalences of bilateral disease, and also limit attempts at statistical analysis regarding the association between gender and monocular visual impairment. Additionally, this makes the causes reported highly dependent on just a few number of cases, possibly missing uncommon causes or skewing the proportions.

The causes of monocular impairment might also not be representative for those causing bilateral impairment – amblyopia is an obvious cause of only monocular VI, but cataract can also be expected to cause a larger proportion of unilateral cases, due to a worse disability increasing the chance of cataract surgery.

Advancements in therapeutic options, including increasing rates of cataract surgery, during the over thirty years since the material was collected, makes the studied population less representative of the population of today.

The leading cause of blindness in a specific eye is not in all cases obvious, and while the cause has been determined by an experienced ophthalmologist after thorough examination, and with access to the patients' medical records and anamnestic information, there remains some room for error if multiple causes are near equally probable.

Considering this, future studies of individuals aged 50 years or older, with enough participants that statistical analyses are possible also for more infrequent conditions such as bilateral blindness, would be of interest to better estimate the prevalence and causes of blindness and visual impairment of the older Swedish population – especially considering more recent advancements like frequent cataract surgery, and therapies for AMD and diabetes.

6.5 Conclusion

The prevalence of visual impairment (including blindness) in at least one eye was 8.9% (95% CI: 7.0–11.1). Cataract accounted for one third of cases, followed by amblyopia, glaucoma, macular degeneration and diabetes. Age, but not gender, was significantly associated with monocular visual impairment.

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