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Degree project work

Prevalence of Cataract changes in a Guatemala population evaluated by Direct Ophthalmoscopy

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Prevalence of cataract changes in a Guatemala population evaluated by direct ophthalmoscopy

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Degree Project Work in Optometry, 15 hp
Bachelor of Science

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Abstract

Purpose: To grade cataract changes in a Guatemala population with direct ophthalmoscopy and a grading system based on the grading system used by V. Mehra and D. C. Minassian in 1988.

Methods: A population from Guatemala who attended field clinics conducted by Vision For All were included in this study. The sample consisted of 352 participants, 219 women and 133 men, from 9-90 years old. Mean age of the participants was 47.9 ± 17.8 years old. Binocular VA and subjective refraction was obtained with trial lenses and a Snellen E-chart at 5 meters. A 2 mm pinhole was used monocularly with the subjective refraction and whether participants felt any improvement in VA was documented. The opacities in the red reflex in the crystalline lens were graded using a handheld direct ophthalmoscope. The grading was made in an angle of 25^{o} nasal and at approximately 33 cm from the participant's undilated eye.

Results: The prevalence of cataract was 28.6% and 68% had some form of opacity in the red reflex. There was no statistically significant difference ($p > 0.05$) between the grade of lens opacities in right and left eye. Mean grade of lens opacities in right eye was 1.64 ± 1.46 and 1.63 ± 1.43 in left eye. The analysis showed a highly significant correlation between age and grade of lens opacities in right eye ($y = 0.0657x -1.5106$; $r = 0.8$; $p < 0.001$) and left eye ($r = 0.78$; $p < 0.001$). Lens opacities start to develop at an average age of 38.5 years in this population. There was a significant correlation between aided VA and grade of lens opacities for right eye ($r = 0.52$; $p < 0.05$) and left eye ($r = 0.49$; $p < 0.05$). 72 participants (20.5%) who had grading 3-5 in one or both eyes felt an improvement in their vision with the pinhole.

Conclusions: The prevalence of cataract was 28.6% and this population had an earlier development of cataract compared to previous studies. This could be due to the UV-radiation, the temperature and nutrition and antioxidant insufficiency. Also this study showed a highly significant correlation between age and grade of lens opacities and a low, but significant, correlation between aided VA and grade of lens opacities.

Summary

Syftet med denna studie är att gradera linsförändringar hos populationer i Guatemala med direkt oftalmoskopi och ett graderingssystem baserat på graderingssystemet som användes av V. Mehra och D. C. Minassian 1988.

Mätningarna är gjorda på personer i Guatemala som sökte till Vision For Alls fältkliniker för problem med synen. 352 personer, 219 kvinnor och 133 män, från 9-90 år är med i studien. Medelåldern var 47,9 ± 17,8 år. Personerna blev registrerade och binokulär visus mättes efter att en subjektiv refraktion utförts med hjälp av provglas och en Snellen E-syntavla för 5 meter. Ett pinhole, 2 mm i diameter, användes monokulärt tillsammans med bästa refraktionen för att undersöka om personen tyckte att synen förbättrades, var den samma eller försämrades med pinholet. Sist i undersökningen graderades linsförändringarna i rödreflexen med ett handhållet oftalmoskop. Graderingen gjordes i en 25^{o} nasal vinkel och cirka 33 cm från personens odillaterade öga.

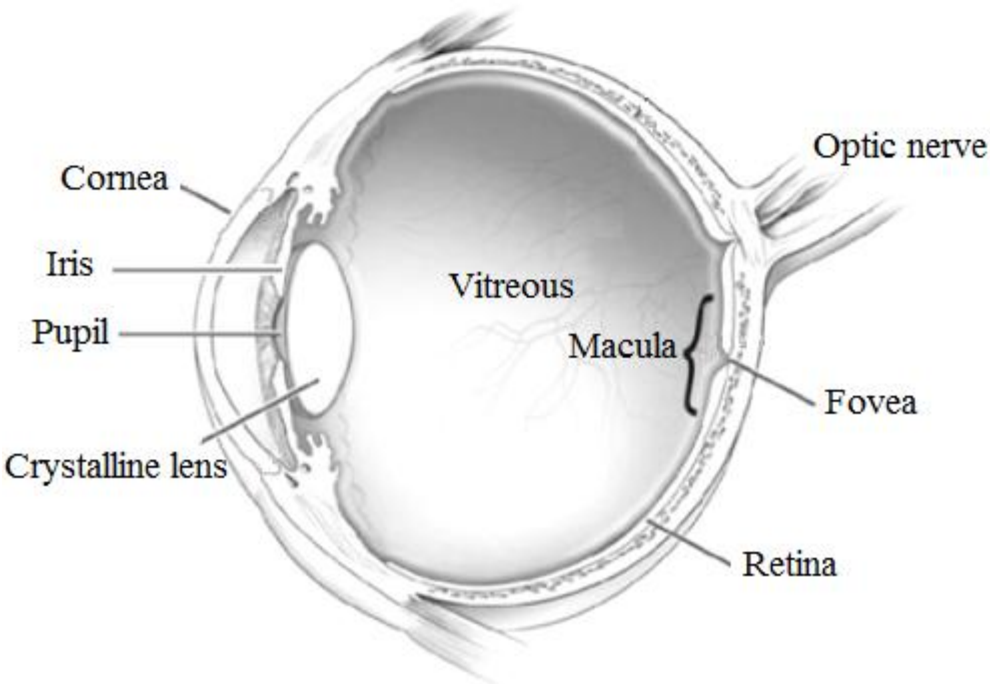
Resultaten visar att kataraktprevalensen var 28,6% och 68% hade någon form av opacitet i rödreflexen. Det finns ingen statistisk signifikant skillnad ($p > 0,05$) i grad av linsopacitet mellan höger och vänster öga. Medelgraden i höger öga var 1,64 ± 1.46 och 1.63 ± 1.43 i vänster öga. Analysering visar ett högt signifikant samband mellan ålder och opacitetsgrad i höger ($y = 0,0657x – 1,5106$; $r = 0,8$; $p < 0,001$) och vänster öga ($r = 0,78$; $p < 0,001$). Linsgrumlingar börjar i genomsnitt utvecklas efter 38,5 års ålder för denna population. Ett signifikant samband mellan korrigerad visus och opacitetsgrad fanns för höger ($r = 0,5183$; $p < 0,05$) och vänster öga ($r = 0,4857$; $p < 0,05$). Hos 72 personer (20,5%) med kataraktgrad 3-5 i ett eller båda ögonen kände denne att synen förbättrades i det kataraktdrabbade ögat med pinhole.

Kataraktprevalensen var 28,6% och det fanns en tidigare utveckling av katarakt i denna population jämfört med andra tidigare studier. Detta kan bero på UV-strålningen, klimatet och närings- och antioxidantbristen från maten. Denna studie visar också ett starkt signifikant samband mellan ålder och grad av linsförändring och ett svagt, men signifikant, samband mellan korrigerad visus och grad av linsförändring.

Contents

1 Introduction

1.1 The anatomy and physiology of the lens



Picture 1.1 Structures of the eye. Based on**:** National Eye Institute, National Institutes of Health Ref#: NEA08

The eye contains many different structures, see picture 1.1. Light rays coming from outside and refracts about 40 D in the cornea and 20 D in the lens to form a sharp upside-down picture in the macula on the retina (Bergmanson, 2010). A healthy lens is transparent due to the avascularity and that the hexagonal lens fibers are perfectly organized and well crowded (Kanski, 2007).

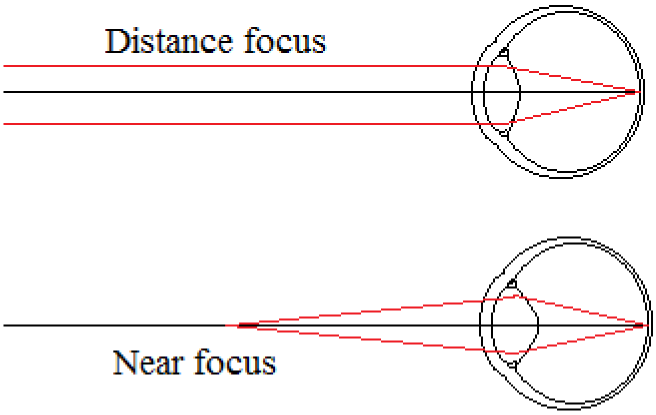
1.2 The development of the Crystalline Lens

The crystalline lens starts to develop after 22 days in the phase of fetus. Surface ectoderm, a outgrowing of the forebrain, bends and creates an optical vesicle, the lens capsule (Bergmanson, 2010). The thickness of the lens capsule, mostly consisting of collagen, varies around the lens. This capsule is important for the lens. It protects against bacteria and allows the lens to change shape and its refractive power. Even though the lens capsule is very elastic it does not consists of any elastic lens fibers. The elasticity allows due to the lamellar well organized structure of the fibers (Remington, 2005). In the lens capsule the primary lens fibers creates and stretches from the back of the capsule to the front. In this phase they lose their nucleus and become transparent. The hexagonal shaped lens fibers made of crystalline constitute the embryo nucleus. New secondary lens fibers develop in the lens epithelium at the equator inside the primary lens fibers. These are the fetal nucleus (Bergmanson, 2010). The lens epithelium produces half of its energy from the oxygen, but the lens fibers uses almost only the anaerobic glycolysis for its energy (Beebe, 2003). Outside the secondary lens fibers adult and cortex fibers are created that grow throughout the whole life. During the first period of time the lens gets nutrition through the hyaloid artery (Bergmanson, 2010). But this artery regresses and the lens gets nutrition and oxygen from intraocular aqueous in the anterior chamber instead (Kanski, 2007). In some eyes you can find a rest of the hyaloid artery, called Mittendorf's dot, in the back of the lens capsule (Bergmanson, 2010).

At birth the crystalline lens is transparent to let through light. But when it grows with age it gets a more yellow hue. Because of this the blue shortlenght light, 315-400 nm, absorbs more and light scattering appears. There is also a morphologic disturbance in the nucleus going on and more protein collects. The yellow hue of the lens can also come from the ultraviolet light that the lens nucleus absorbs (Beebe, 2003). The lens protects the eye from ultraviolet radiance, UV-radiance. It protects the eye from 50% of 390 nm light and 100% from the 360 nm light (Beebe, 2003). An adult lens is approximately 4 mm thick and 10 mm in diameter, but the axis anterior to posterior grows 0.023 mm/year. The lens weight changes with age from 92 mg when one month old to 152.8 mg when 10-20 years old and 258.1 mg when 80-90 years old. 40% of the lens is water and 60% is protein, but the protein part increases with age (Bergmanson, 2010).

1.3 Accommodation

The lens is a part of the accommodation. This process makes the eye focus at near, see picture 1.2, refracts the light correctly in the eye and make light rays create a clear picture on the retina (Remington, 2005). In accommodation the lens changes shape with help from the zonula fibers that are attached between the lens equator and the sphincter muscle, the ciliary muscle. When the ciliary muscle contracts the zonula fibers relaxes so that the lens gets a more convex shape, to break the incoming light more (Beebe, 2003).



Picture 1.2 The accommodation of the lens.

1.4 Cataract

Cataract develops when the crystalline lens starts to get cloudy and opacities develop that makes the lens absorb and scatter light more than a non cataract affected lens (Oyster, 1999). Visual impairment increases with increasing age, so does the grade of cataract (Marmamula, Ravuri, Boon & Khanna, 2013). Cataract is the leading cause of blindness in the world and it is a major health issue. Almost 20 million people in all ages are blind because of cataract (Pascolini, 2011)! According to WHO 2010, cataract causes 51% of world blindness, although it can be surgically removed with success in restoring sight. The numbers of people with cataracts increase as people live longer. Sadly people in developing countries do not have the same availability to surgery.

1.4.1 Risk factors of cataract

- Age (Bergmanson, 2010; Grosvenor, 2007; Truscott, 2005)
- Radiance like UV, x-ray and heath (Bergmanson, 2010; Grosvenor, 2007; Roberts, 2011; Leske, Chylack & Wu, 1991)
- Smoking (Bergmanson, 2010; Grosvenor, 2007; Leske et al., 1991; Cumming, 1997)
- Diabetes (Bergmanson, 2010)
- Gender, female (Carlson & Sjöstrand, 1996; Leske et al., 1991)
- Genetic sensitivity (Grosvenor, 2007; Leske et al., 1991)
- Antioxidant insufficiency in the food (Grosvenor, 2007)
- Nonwhites (Leske et al., 1991)
- Trauma (Bergmanson, 2010)
- Drug use for example cortisone and oral steroid therapy (Bergmanson, 2010; Leske et al., 1991)
- Congenital disturbance (Bergmanson, 2010)
- Low education (Leske et al., 1991)
- Glasses before 20 years old (myopic) (Leske et al., 1991)
- High alcohol consuming, four glasses per day or more (Cumming, 1997)
- High BMI (Leske et al., 1991)

People over age of 70 have some kind of decreased transparency in their lenses (Oyster, 1999). Why some people develop more cataracts than others and earlier in life depends on nutrition, medical, personal, environmental and other factors (Leske et al., 1991). There are different types of cataract: congenital, age-related, traumatic and toxic cataract. The most common is age-related cataract (Grosvenor, 2007), because age is the biggest risk factor for cataract (Truscott, 2005). Often cataract participants suffer from glare and light scatter. It can also be hard to decide if a color is green or red, for example traffic lights. With cataract the Ca^{2+} concentration increases dramatically. This makes an abnormal ion and liquid balance and cell membrane permeability in the lens (Grosvenor, 2007).

1.4.2 Different types of cataract

There are different types of cataract, depending on where in the lens opacities are situated. Normally you talk about three types of age-related cataract: nuclear, cortical and posterior subcapsular cataract (Grosvenor, 2007).

1.4.2.1 Nuclear cataract

Nuclear cataract is a thickening of the nucleus of the lens. The person often gets blurry vision and turns more myopic (2.00 to 3.00 D), because of the increased refractive index in the lens. The person can also see blue and purple hues as less sharp, because of the lens's yellow-brown hue (Grosvenor, 2007). Most common the person does not notice anything in the beginning of the cataract development (Bergmanson, 2010). In the middle-age a type of lens barrier becomes apparent and impedes the fluid of small molecules between cortex and the lens nucleus. This leads to lower concentration of GHS, a component that prevent the lens from oxidation (Truscott, 2005).

1.4.2.2 Cortical cataract

Cortical cataract is opacities in the outer layer of the lens, in the cortex. In the beginning of the cataract development, it does not have much visual worsening though the opacities are in the fringe of the lens. Only in low illumination, when the pupil is large, the person can suffer from the cataract (Grosvenor, 2007).

1.4.2.3 Posterior subcapsular cataract

Posterior subcapsular cataract is a small opacity behind the lens capsule. The person often has a hard time seeing at bright, sunny days when pupils contract and are small (Grosvenor, 2007).

Age-related cataract seldom appears before age of 50 (Grosvenor, 2007). But in warmer countries, with more light of 310-400 nm that ages the lens, the cataract debuts earlier (Miranda, 1980). A study showed that the total UV-radiance that a person subject to during many years increases the risk for cortical, but not nuclear, cataract (Taylor, West, Rosenthal, Munoz, Newland, Abbey & Emmett, 1988). Same study also had the conclusion that people who subject to much UV-radiance in early years have higher risk to develop cataract earlier in life than others (Taylor et al 1988). There are more studies having the same conclusion, for example Neale, Purdie, Hirst & Green, 2003. Experiments on rats showed that young rats are more sensitive to UVB-radiance than older rats (Dong, Ayala, Löfgren & Söderberg, 2003) also that pigmented iris protects more than if the pupil is smaller (Löfgren, 2001). But the fact that rats do not have the same pigmentation as primates make this results a bit hesitant.

1.4.2.4 Mixed and Congenital cataract

More types of cataract are the mixed and the congenital cataract. Mixed type is common and it is a mix of two or three other cataract types; nuclear, cortical and posterior subcapsular cataract (Leske et al., 1991). It is important for newborns with congenital cataract to undergo surgery to avoid strabismus and amblyopia.

1.4.3 Diagnose

There are different systems to grade and classify the cataract. The most accepted system to grade cataract is the Lens Opacities Classification System III, LOCS III (Chylack, Wolfe, Singer, Leske, Bullimore, Bailey, Friend, McCarthy & Wu, 1993). This is based on LOCS II (Chylack, Leske, McCarthy, Khu, Kashiwagi & Sperduto, 1989) that contained four pictures of lenses to grade nuclear cataract, five pictures for cortical cataract and four pictures for posterior subcapsular cataract. LOCS III contains more colored pictures of lenses with different types and grades of cataract, viewed with different illuminations of the slit-lamp. To grade nuclear cataract there are six pictures of the opalescence from lens and the lens color (NO1-NO6 and NC1-NC6). The cortical and posterior subcapsular cataract grading has five pictures in retro-illumination each (C1-C5 and P1-P5). The grading can be done directly when the participant sits in the slit-lamp or from pictures of the participant's eye from the slit-lamp. It is an easy and repeatable method that makes all examiners grade the same way. And it can be used both in cross-sectional and longitudinal studies (Chylack et al., 1993).

Easiest way to detect a cataract is in direct ophthalmoscope. If the pupil is un-dilated the cataract shows better with ophthalmoscope than with biomicroscope. Diagnose should be predicated both of participant's symptoms and clinical findings (Grosvenor, 2007). There are also other grading system like the Wisconsin and the Wilmer grading system.

1.4.4 Treatment

To decrease the risk of cataract is to not smoke and minimize subject of UVB-radiance (Brian & Taylor, 2001). Vegetarians have 96% decreased risk to develop cataract than people who eat meat (Appleby, Allen & Key, 2011). Also multivitamin supplements decrease the risk of all types of cataract and supplements of riboflavin, carotene, niacin, thiamine, iron, vitamin C and E decreases the risk of cortical, nuclear and mixed cataract (Leske et al., 1991).

1.4.5 Surgery

Back in the days they wanted the cataract to “maturate” before they did surgery, but today you can do surgery in any phase. To decrease the complication risk of the surgery you should do it as early as possible (Grosvenor, 2007). To reduce visual impairment in the world, caused by cataract, the cataract surgery rate must be greater than the incidence rate of cataract (Foster, 2000). Only available treatment of cataract today is surgery. Removing of the crystalline lens and replacing it with an artificial intra ocular lens, IOL, in the capsular bag (Krieglstein Weinreb, Koch & Kohnen, 2009; Truscott, 2003). Cataract surgeries are one of the most cost-effective interventions of all health interventions (Lansingh, Carter & Martens, 2007). Today worldwide cataract surgery is the most frequent outpatient clinic operation in medicine (Kook, Kampik, Dexl, Zimmermann, Glasser, Baumeister & Kohnen, 2013). But many people do not know about cataract, cannot afford or feel fear of the procedure (Beltranena, Casasola, Silva & Limburg, 2007). The improvements in the surgery technique make it possible as an outpatient procedure under local anaesthesia and normal visual acuity can almost immediately be restored. This makes it more available and increases the possibility of prevent cataract blindness in developing countries (Shan, Gilbert, Razavi, Turner & Lindfield, 2011).

1.5 UV-radiation

Guatemala is in the 11+ zone where extra sun protection is required, especially in April when the UV-radiation peeks (Liley & McKenzie, 2006). You should avoid being outside the time of day when the sun is strongest and sunglasses and sun protection for the skin is important (WHO, 2002).

Light below 400 nm is called UV-radiation and is divided into three categories:

UVA 315-400 nm
UVB 280-315 nm
UVC 100-280 nm

Most of the radiation reaching earth is UVA-radiation. All of the UVC and 90% of UVB-radiation are absorbed by the ozone, oxygen, carbon dioxide and water vapour, but the atmosphere affects the UVA-radiation less (WHO, 2002). The light transmission properties of the eye vary depending on nature and age. Long-wavelength light is transmitted by the cornea and lens. Light below 300 nm is absorbed by the cornea, but transmitted by aqueous to the lens. Light below 360 nm is filtered by the lens and light below 300 nm is blocked by it (Forrester, Dick & McMenamin, 2008). The lens absorbs light between 300 and 400 nm (Remington, 2005).

1.6 Visual acuity

Visual acuity, VA, is the most common vision examination at a clinician (Elliott, 2003). It is a rate of the smallest resolving angel, the eye's possibility of detect details measured in seconds of arc (Benjamin, 2006). It is the resolution or the function of the eye to see two objects as separated from each other (Grosvenor, 2007). Important concepts are: detection, localization, resolving and identification. First the person has to detect the object and locate it from others. Then be able to resolve patterns and details in the object, for example in what direction an E is oriented. Finally the person has to identify the object (Lundström, Gustafsson & Unsbo 2007; Lay, Wickware & Rosenfield, 2009).

To measure VA some type of acuity chart is required. It can be a projector with visual slides or wall-mounted acuity chart (Carlson & Kurtz, 2004). High contrast visual acuity is relatively good in cataract patients with blurry vision. But low contrast visual acuity and the vision in real life is often worse (Grosvenor, 2007).

1.6.1 Different types of acuity charts

1.6.1.1 Snellen chart

One type of acuity chart is the Snellen chart. The chart is designed with one optotype at the top and more optotypes for every row as the size of the optotype decreases. All optotypes are five units high and four or five units wide. One unit is one minute of arc. The separation between the lines in the optotypes is the same as the width of the lines. That means that the bars in an E have the same width as the separation between them. The chart contains both letters like E and H with space between the bars and letters without space like L and T (Grosvenor, 2007).

1.6.1.2 LogMAR

The LogMAR chart is standard used in clinic research and in clinic testing of ophthalmologic products and pharmacology (Benjamin, 2006). The chart is logarithmic scaled with equal number of optotypes per row with same spacing between and decreased size of the optotypes down (Grosvenor, 2007). It is more sensitive than the Snellen chart (Elliott, 2003).

1.6.2 Different types of VA

Table 1.1 Relation between decimal, Snellen and LogMAR visual acuity.

Decimal	Snellen (5 m)	LogMAR
0,04	5/125	1.4
0,06	5/80	1.22
0,12	5/40	0.92
0,16	5/32	0.8
0,2	5/25	0.7
0,32	5/16	0.5
0,4	5/12,5	0.4
0,63	5/8,0	0.22
0,8	5/6,3	0.1
1,0	5/5,0	0
1,25	5/4,0	-0.1

1.7 Pinhole

Before possible cataract surgery VA should be obtained for distance and near, with and without glasses, and with pinhole if indicated. Using Snellen chart is most common for obtaining VA of participants with cataract (Vajpayee, 2005). Viewing through a pinhole increases the depth of focus in the eye and decrease the retinal blur (Carlson & Kurtz, 2004). Openings in the cataract can easier be fined. This is an inexpensive, simple and relatively reliable method to estimate the potential vision for the patient without coexisting disease after undergoing an uncomplicated cataract surgery. With a pinhole the retinal function is estimated (Melki, Safar, Martin, Ivanova, & Adi, 1999). If the VA increases with pinhole there *could* be a cataract opening or an uncorrected refractive error, but it shows that the retina and visual pathways are normal. If VA not improves it is not optically based. It could be a central cataract, scotoma, posterior segment disease or retinal pathology (Marmamula, Ravuri, Boon & Khanna, 2011; Melki et al., 1999; Carlson & Krutz, 2004).

1.8 Vision For All

Vision For All, VFA, was started in 1995 of John Goddoy. This non-profit organization wants to make people in developing countries be able to study and work. The organization together with eye care professionals examine eyes of people in need and distribute previously worn glasses for a small amount of money or for free. VFA collects, cleans and measures the power on previously worn glasses. These glasses are then distributed to people in need all over the world, after an eye examination of an optometrist (Vision For All, 2012). This makes the everyday life and work easier for the people in developing countries.

1.9 WHO Definitions

The World Health Organization, WHO, has definitions of different grades of vision:

VA 1.0 to 0.3 - NORMAL vision.

VA < 0.3 to 0.1 - VISUAL IMPAIRMENT, VI

VA < 0.1 to 0.05 - SEVERE VISUAL IMPAIRMENT, SVI

VA < 0.05 to no perception of light - BLIND

All visions are in the better eye and with available correction. Less than 10 degrees central field of vision is equivalent to blindness and VA < 0.3 to 0.05 is sometimes called Low Vision (WHO, Vision 2020).

1.10 Previous similar studies

Similar measurements like this study have been made in marine fishing communities in South India 2011. Unaided, aided and VA with pinhole was measured with a Snellen chart at 6 m of people 40 years and older. VA with pinhole was only measured if VA was < 0.5 in any eye. Eye examination with torch was only made if the VA was < 0.3 in any eye. Results from this study showed that the visual impairment had a prevalence of 30% and that cataract was the leading cause, followed by uncorrected refractive errors. 2.7% was blind and 92.8% of the blindness was caused by cataract (Marmamula et al., 2011).

In the study from 2009 made in Sao Paulo State, Brazil, unaided and best aided visual acuity, biomicroscopy and fundoscopy was obtained. Using LOCS II showed a prevalence of cataract of 4.94% and mainly affected people over 50 years old (Carlos, Schellini, França de Espíndola, Lana, Rodrigues, & Padovani, 2009).

To assess the cause of blindness, SVI and VI in Iran a study was made in 2009 with 3000 citizens age 50 and older. VA was measured with “E”-chart with and without pinhole and ophthalmologists examined participants with VA < 0.3 in any eye. This showed that cataract, surgery complications, refractive errors and corneal scars caused 56.1% of the blindness, 65.0% of SVI and 85.6% of VI. Cataract was the leading cause of blindness and SVI (Rajavi, Katibeh, Ziaei, Fardesmaeilpour, Sehat, Ahmadieh, & Javadi, 2011).

Another similar study was made 2007 in an urban area of Paraguay among participants 40 years and older. VA with and without pinhole was obtained with “E” Snellen chart at 6 m. Participants anterior segment were also examined in slit-lamp. Here cataract was the only cause of blindness and main cause of low vision (Yaacov-Peña, Jure, Ocampos, Samudio, Furtado, Carter & Lansingh, 2012).

A study finished in 1992 with Barbados-borned citizens showed that the prevalence of bilateral blindness was 1.65% and VI was 5.69%. In this study 4631 40-84-years old people participated. The aided VA and field of sight were obtained. The cataract was graded with LOCS II and all participants were interviewed. The leading cause of blindness was cataract and open angle glaucoma. The total prevalence of cataract was 40.9%. Other causes of blindness were macula and retina diseases and optic atrophy (Hyman, Wu, Connell, Schachat, Nemesure, Hennis & Leske, 2001).

According to the cross-sectional study among participants aged 50 to over 80 in the Praksam district in India 2013, 32.4% had cataract. VA and VA with pinhole were obtained using Snellen chart at 6 m. Then torch examination and direct ophthalmoscopy was performed. Of all participants with VI cataract caused 57.1% (Marmamula et al., 2013).

To detect prevalence of VI from cataract and cataract surgical in Guatemala 4806 participants 50 years and older were examined. VA with and without pinhole and ophthalmic examination to assess the lens status was made. Results showed that 3.7% of the participants had bilateral cataract and cataract is the major cause of bilateral blindness, 66.1% (Beltranena et al.,2007).

According to the Eye Disease Prevalence Research Group the prevalence of cataract in either eye in the USA was 17.2% year 2004 among people 40 to over 80 years old. The LOCS II, Wisconsin and Wilmer grading system was used to grade the cataract (Congdon, Vingerling, Klein, West, Friedman, Kempen, O'Colmain, Wu & Taylor, 2004).

A study from 1995 in Salisbury, United Kingdom, showed a prevalence of cataract of 36.4% using the Wilmer cataract grading system among participants 65 to over 80 years old (West Murioz, Schein, Duncan & Rubin, 1995).

The prevalence of cataract in Australian population aged 40 to 101 years old 1999 was 29.63%. All 3271 participants were clinical eye examined including lens photography and the unaided and aided VA was measured. Also participant information about health, lifetime ocular ultraviolet B exposure and dietary was collected (McCarty, Mukesh, Fu & Taylor, 1999).

In all studies above, the WHO definition of blindness, SVI and VI was used.

2 Purpose

To grade cataract changes in a Guatemala population with direct ophthalmoscopy and a grading system based on the grading system used by V. Mehra and D. C. Minassian in 1988.

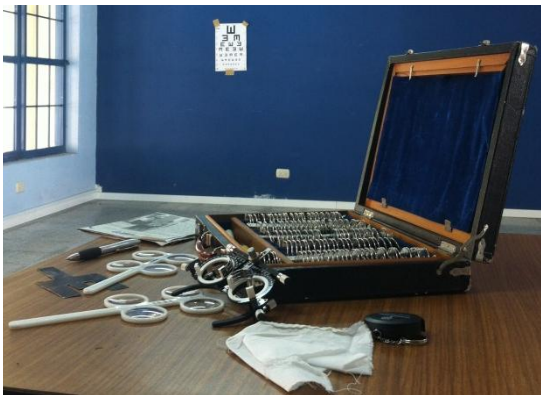
3 Material and Method

3.1 Sample

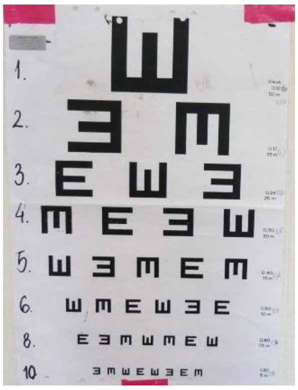
The sample was Guatemala people seeking for vision problem at field clinics of Vision For All. The eye examinations, provided by Swedish optometrists, were made 2013-04-01 to 2013-04-13 in different villages around Lake Atitlan and Guatemala City. The sample consisted of 219 women and 133 men from 9-90 years old. All data was collected by the writer of the present study during eleven clinic days.

3.2 Equipment

- Trial lens case (picture 3.1).
- Binocular flippers containing +1.00/+1.50 D, +2.00/+2.50 D (picture 3.1).
- A Snellen tumbling E-chart designed for 5 meters with E:s orientated either right, left, up or down in a random fashion (picture 3.2).
- Pinhole with diameter 2 mm.
- Handheld ophthalmoscope of type Heine Beta 200S
- Clinic records (Appendix 1.1).
- Clean, measured previously worn glasses from Sweden.



Picture 3.1 Trial lens case and flippers.



Picture 3.2 Snellen E-chart

3.3 Procedure

The participants were first of all registered on a personal clinic record (see Appendix 1.1) where they reported data such as name, gender, age and if they could read. To obtain the binocular unaided and aided VA and the effect with pinhole, a Snellen tumbling E-chart at 5 m was used. The optotypes was from VA 0.12 to VA 1.2. An assistant pointed at the E-chart and the participant was instructed to show the direction of the appointed E with the hand. The assistant pointed at E:s with higher VA until the best unaided VA in either eye was found. For undertake the participant's refraction a trial lens frame, a case of trial lenses and flippers with different powers was used. The participant reported if the VA was better with or without both +0.50 D and -0.50 D flipper in front of the participants eyes to ensure the best possible vision. If VA improved with +0.50 D flipper the participant was introduced to +1.00 D flipper. And if this improved the VA +1.50 D flipper was introduced and so on until the best VA was found. If the refraction indicated more than +2.50 D the trial lens frame and trial lenses was used instead of flippers. If +0.50 flipper did not improve VA the participant was introduced to +1.00D. If no improvement the participant was introduced to -0.50 D trial lenses in the trial lens frame. If this did not improve VA the participant was introduced to -1.00 D trial lenses, but if the VA did not improve the participant was considered no need of glasses. If -0.50 D trial lenses improved VA the participant was introduced to -1.00 D trial lenses and so on until best binocular aided VA was found. No cylinder components were estimated. If the VA of the participant did not improve with either plus or minus and astigmatism was indicated, the participant got an empty frame and was referred to a local optometrist.

3.3.1 Measuring the pinhole effect

After finding the best aided VA the optometrist or the participant occluded one eye. In the case the participant occluded one eye he/she was perused to not cheat. Pinhole was held by the participant or the optometrist in front of the tested eye with the distance correction. The participant was instructed to search for the small hole and compare the E-chart with and without the pinhole. Report whether participant felt the vision was improved, same or worse with the pinhole was documented. This procedure is from now on referred as obtaining the pinhole effect. Then same procedure was made on the other eye.

Picture 3.3 Obtaining the pinhole effect

3.3.2 Grading of the lens opacities

Last in the examination the lens opacities were graded by a handheld ophthalmoscope seated on +2.0 D. With this the lens opacities was graded according to a grading system based on the grading system used by V. Mehra and D.C. Minassian 1988. The participant was instructed to look in the direction of the E-chart. Findings in the red-reflex were examined from all directions, but the final grading was made in an angle of 25^{o} nasal at approximately 33 cm from the participant's eye, to reduce pupil constriction.

Picture 3.4 Grading of the lens opacities.

The fact that same optometrist obtained all measurements makes the lens opacities grading equal in all participants. The grading system in V. Mehra and D.C. Minassians article is a well-tried, repeatable method with almost perfect consistency between different examiners. The method refers to grade the opacities in the red reflex of the lens that can disturb the participant's vision. The procedure is done in non-dilated eyes with direct ophthalmoscopy (Mehra & Minassian, 1988). To facilitate the communication between participant and optometrist sometimes an interpreter translated from Spanish to English. When an interpreter not was available a phrase book designed by VFA was used. All record keeping of examination results was made on records (see Appendix 1.1) and finally signed by the executed optometrist. All the examinations were made in indoor environment during a travel with the non-profit organization Vision For All.

Figure 3.1 The grading system used in the study to grade the opacities in the red reflex. It is based on the grading system used by V. Mehra and D.C. Minassians in 1988.

Grade 0	No opacities, clear red reflex.
Grade 1	Few small dot opacities in the lens appearing as tiny scattered dark spots in the red reflex, occupied maximal area of 1 mm^2 of the red reflex.
Grade 2	Lens opacities obscuring smaller area than the area of clear red reflex.
Grade 3	Obscured area of opacities in the red reflex is equal or larger than the area of clear red reflex.
Grade 4	Lens opacities obscuring the whole red reflex.
Grade 5	No red reflex.

4 Results

4.1 Analysis

Data management and analysis was conducted using Microsoft Excel 2010. Data analysis, including t-test, regression analysis, bar graphs, mean values and standard deviations were conducted.

4.2 Analyzed results

Totally 352 participants' right and left eyes were examined, that equals 704 eyes. 133 of the participants were men, 37.8%, and 219 women, 62.2%. Four participants were excluded from the study. Two participants did not see with their left eye because of stroke and accident. Two participants' eyes were not possible to grade because of opaque cornea from injury and sickness. Mean age of the participants was 47.9 ± 17.8 years old.

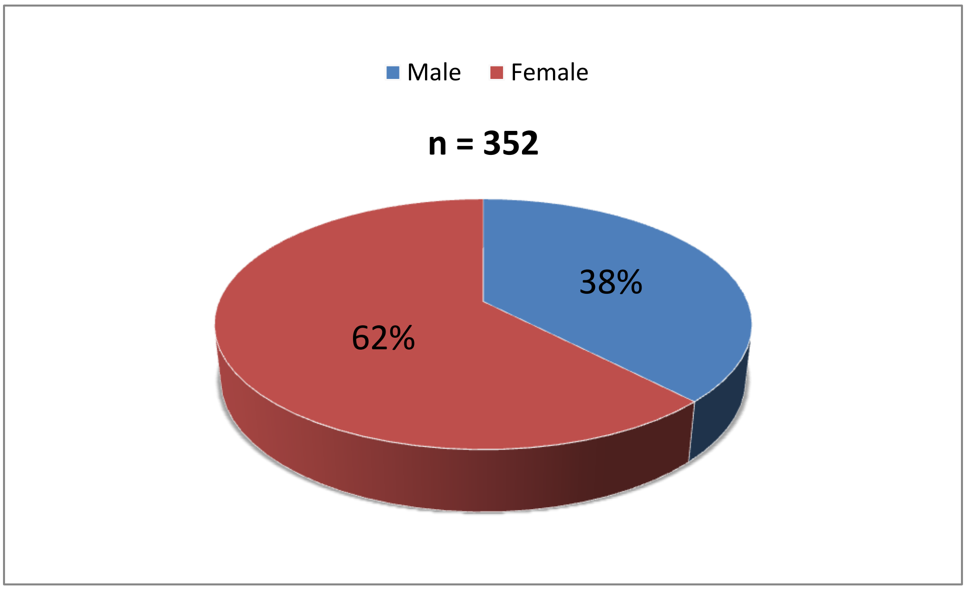


Figure 4.1 Numbers of participants in the study.

To show the number of participants with each grade of lens opacities a bar graph was made. Results are showed in figure 4.2.

The total grade of lens opacities in right eye was 577 and in left 575. The most frequent grade of lens opacities was grade 0 and grade 2. 479 eyes, 68 %, had some type of opacity and the number of eyes with grade 3-5 was 201, 28.6%.

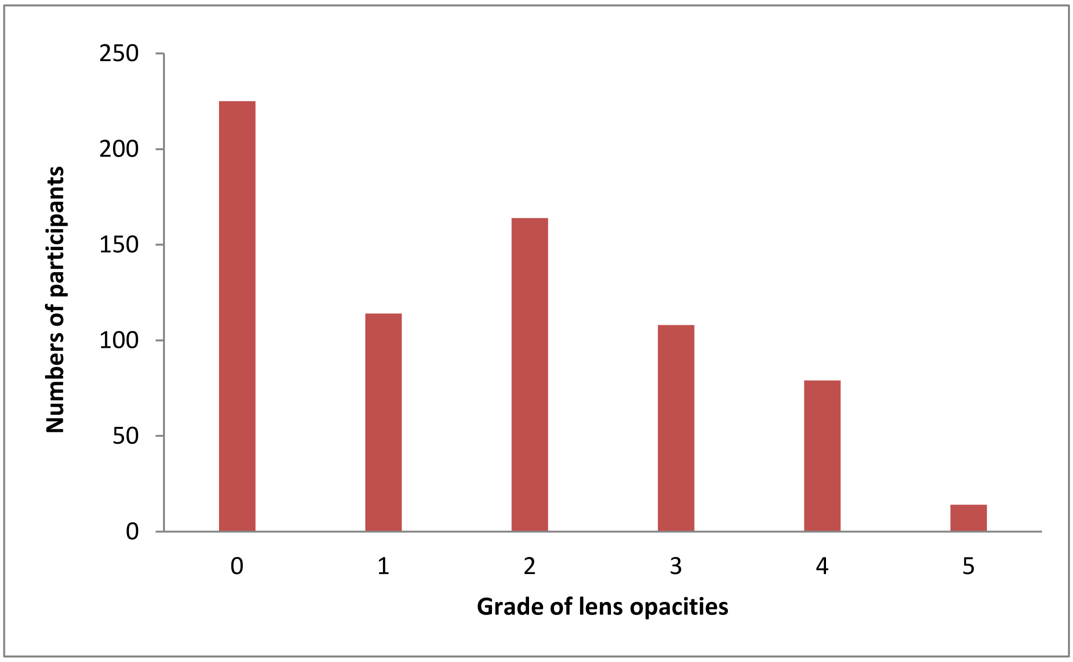


Figure 4.2 Number of participants with each grade of lens opacities.

A bar graph was made to show the grade of lens opacities and the age of participants. The results are shown in figure 4.3. Most lens opacities had participants 71-90 years old in the right eye.

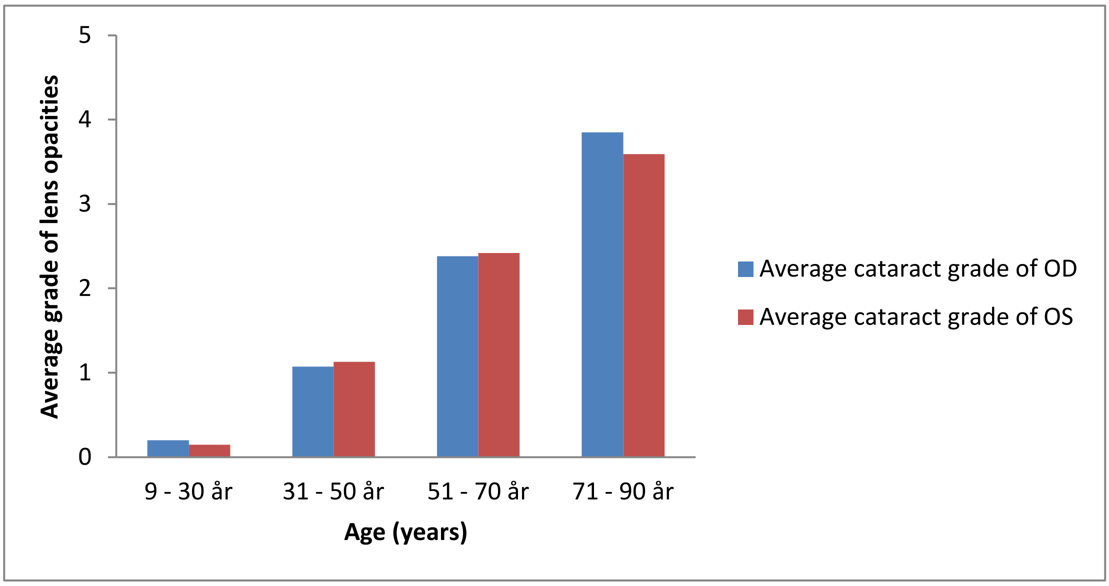


Figure 4.3 Average grade of lens opacities versus age of the participants.

A bar graph was made to show number of participants with a special grade of lens opacities in right eye. Results for the numbers are shown in figure 4.4.

A t-test was performed to compare the grade of lens opacities between right and left eye. There was no statistically significant difference ($p > 0.05$). Mean grade of lens opacities in right eye was 1.639 ± 1.46 and 1.634 ± 1.43 in left eye.

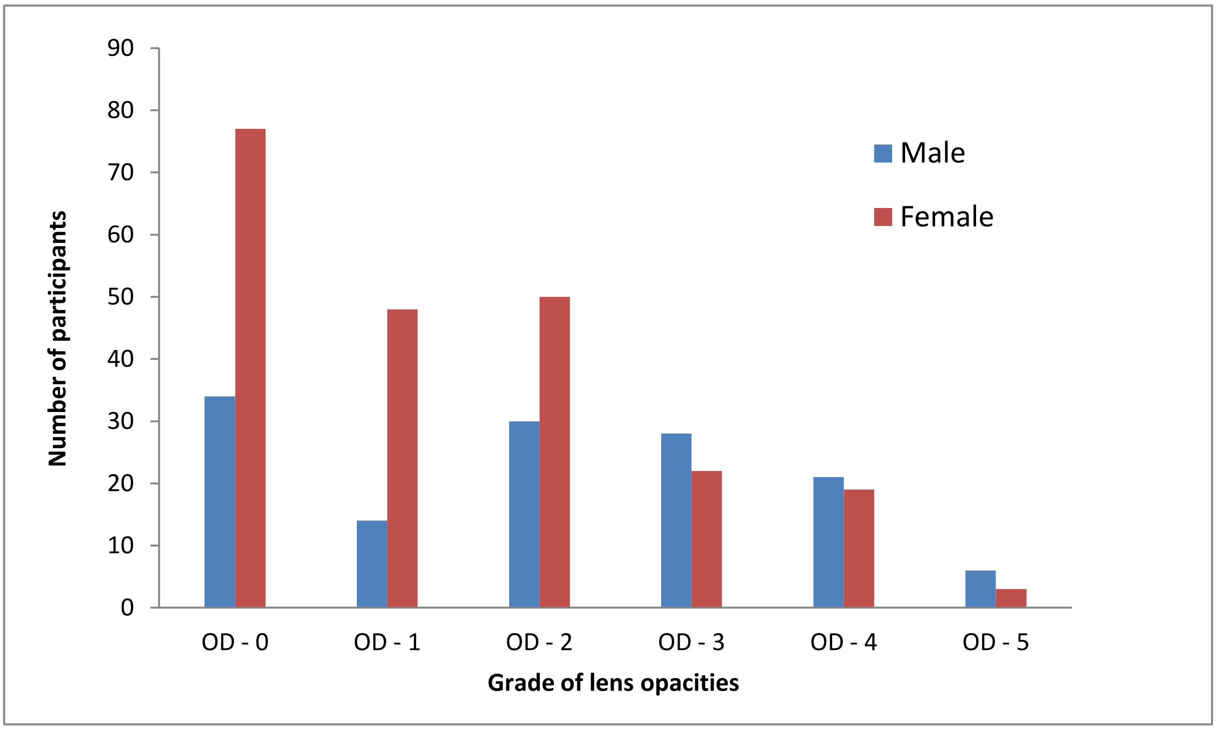


Figure 4.4 Numbers of participants versus grade of lens opacities in right eye.

A regression analysis was performed to compare the age and grade of lens opacities in right and left eye. There was a highly significant correlation between age and grade of lens opacities in both right ($r = 0.8$; $p < 0.001$) and left eye ($r = 0.78$; $p < 0.001$). Results are shown in figure 4.5.

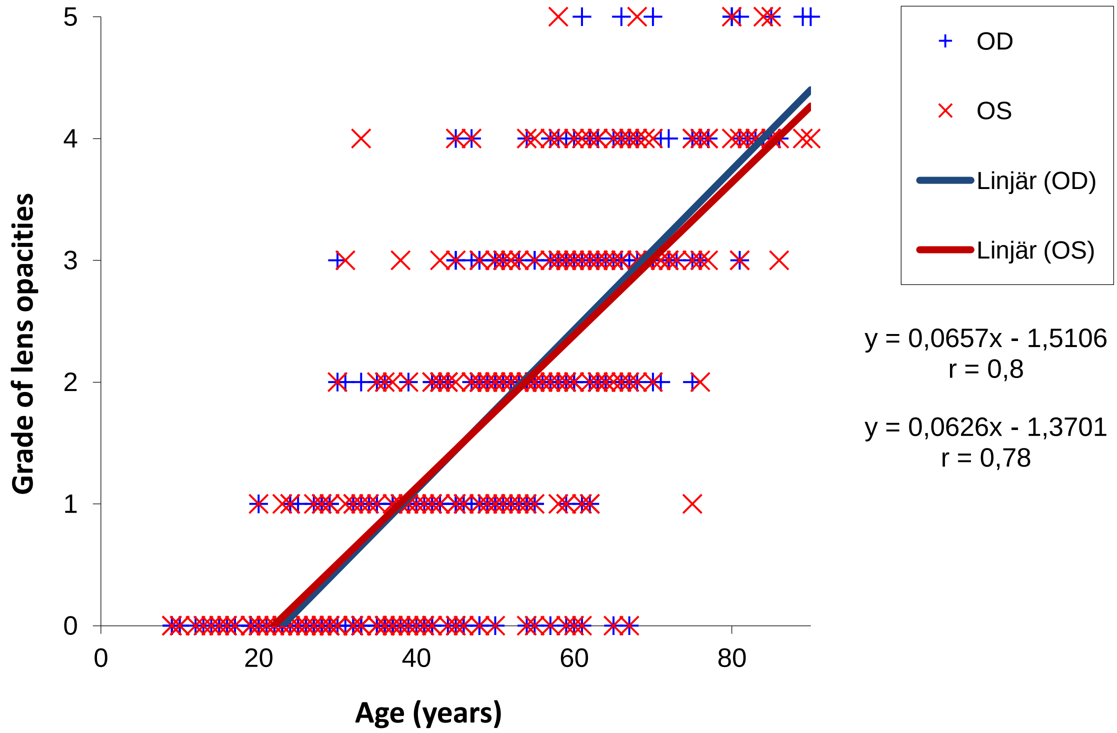


Figure 4.5 Correlation of age and lens opacities grade.

To compare the correlation of best aided VA with grade of lens opacities a regression analysis was performed. A low, but significant, correlation was found between aided VA and grade of lens opacities for right ($r = 0.5183$; $p < 0.05$) and left eye ($r = 0.4857$; $p < 0.05$). Results are shown in figure 4.6.

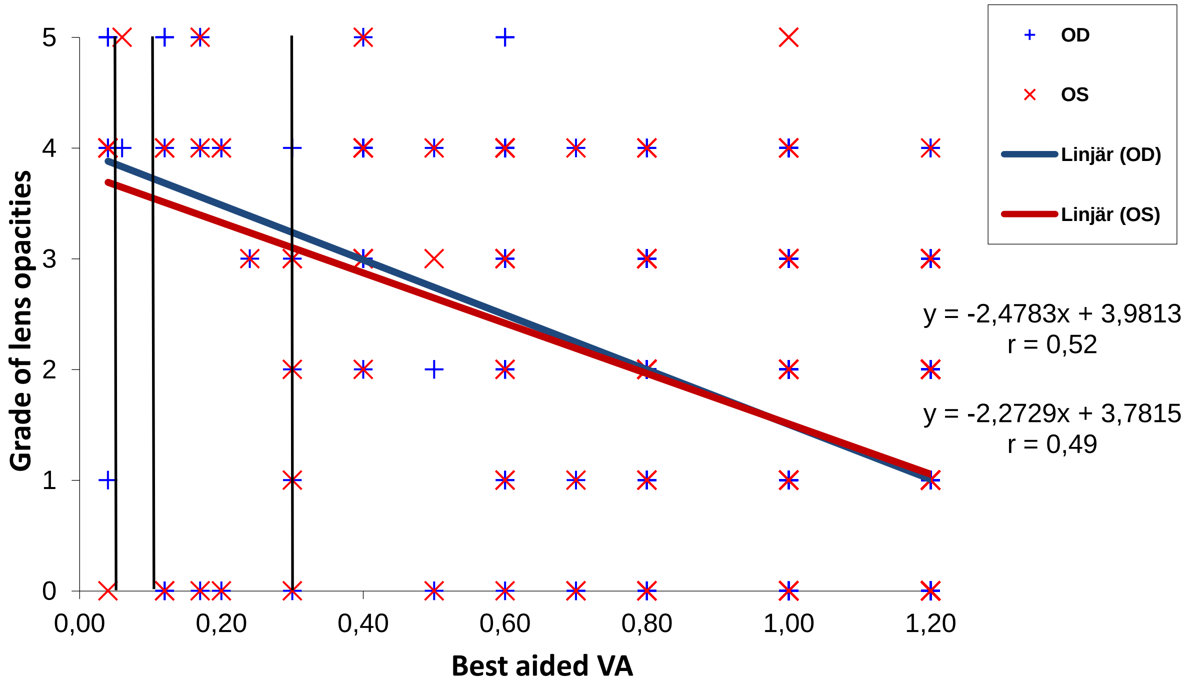


Figure 4.6 Correlation of lens opacities grade versus aided VA.

To see if there was any difference between unaided and aided VA a two-tailed t-test was performed. A highly significant difference ($p < 0.001$) was present. Mean unaided VA was 0.7 ± 0.38 and aided VA 1.0 ± 0.31.

For 58.2% of the participants the pinhole improved the vision in right eye and 59.7% in the left eye. In 15.9% of the participants the vision with and without pinhole is the same in right eye and 15.6% in the left eye. 25.9% of the participants reported a worsening in the vision with pinhole in front of the right eye and 24.7% in the left eye. In 72 participants, 20.5%, with cataract grade 3-5 in one or both eyes the pinhole improved vision. Results for right and left eye are shown in Table 4.1.

Table. 4.1 The effect with pinhole.

	Better	**Same**	**Worse**
Grade 1	65	30	19
Grade 2	92	46	26
Grade 3	58	26	24
Grade 4	44	19	16
Grade 5	5	8	1

5 Discussion

This study showed that 68% of all eyes had some type of opacity. This is higher than in other previous similar studies from other countries (Carlos et al., 2009; Hyman et al., 2001; Marmamula et al., 2013; Congdon et al., 2004; West et al, 1995; McCarty et al., 1999). But the prevalence of grade 3-5 was 28.6%. Participants having grade 3 or higher can be regard as having cataract. There is not much data available on prevalence of cataract in Guatemala. According to a Rapid Assessment of Cataract Surgical Services in Guatemala 2004 a prevalence of 11.9% was obtained (Limburg, Barria von Bischhoffshausen, Gomez, Silva & Foster, 2008). Beltranenas study showed that 66.1% of all bilateral blindness in people 50 years and older was caused by cataract. In 2005, a prevalence of 14% Rapid Assessment of Cataract Surgical Services was obtained in Mexico (Limburg et al., 2008). This study contained participants from 9-90 years old, a good variation of people that actually should give a lower prevalence of cataract. In all previous similar studies the participants were 40 or 50 years and older (chapter 1.10). In this current study the sample was random out of 1430 participants, but the fact that all participants were seeking for vision problem can explain this higher prevalence. Some of their vision problem could be due to cataract. Also the methods used in this compared to other studies are different from each other and results cannot truly be compared. This screening method with a handheld ophthalmoscope was used because of difficulty in carrying bigger and more advanced equipment. But the fact that no opposite trend and no significant difference between lens opacities grade in right and left eye was found, shows that the method used was good and adequate for this study. All the eye examinations were performed indoor, but the illumination settings were different and were not possible to control. For future studies the examinations could be done in same room illumination, preferably in a dark room, for better pupil size. If the pupil is smaller, less opacities are shown in the red reflex. But the fact that the room illumination was same during the whole examination of one participant makes the same relation between for example right and left eye. Best of all would be to dilate participant's eyes to get the whole view of the red reflex. No pupil dilation medication was used in this study because of time restrictions.

Age is an accepted factor of cataract (Bergmanson, 2010; Grosvenor, 2007; Truscott, 2005). Even this study has a highly significant correlation between age and grade of lens opacities in both right and left eye.

Most participants got improved vision with pinhole (table 4.1.). If pinhole improves participant's VA there can be clear areas in the lens or uncorrected refraction errors, but at least the visual pathways and retina are normal. In this study the number of eyes with grade 3-5 was 201, 28.6%. More interesting was that in 72 participants, 20.5%, with cataract grade 3-5 in one or both eyes pinhole improved vision in the cataract affected eye. This means that in 20.5% of all participants a cataract surgery could potentially increase the sight and make a big difference in participant's life. 20.5% is a high number and shows that more cataract surgeries are required. The surgeries have to be more available to everybody in developing countries. For future studies obtaining the VA with pinhole would be a good. This would give a more accurate assessment of the pinhole effect. But because of time restrictions in this study only a subjective estimation from the participant were obtained; better, same or worse *with* the pinhole than without.

In this study most participants were woman, probably because the women were more available for eye examinations during daytime. Due to their tradition and culture, women are working in the home. They take care of the children and the household. Often the men are working in workplaces outside the home and are not available for eye examination during daytime.

Most frequent lens opacity grade was grade 0 and grade 2. Grade 5 was more frequent in men than women and also the average lens opacity grade was higher in older men, probably because the men work more outside than woman. In that way men are subjected to more UV-radiation from the sun.

When examining participants 9-90 years old a lens opacity developing age can be calculated. In Guatemala lens opacities develops at average 38.5 years age (fig. 4.5). This shows that cataract appears earlier in Guatemala than after age of 50 according to Grosvenor, 2007, probably because Guatemala is in the 11+ zone (chapter 1.5) where the UV-radiation and even the temperature is higher. This could speed up the aging of the lens.

While travelling in Guatemala with VFA it was noted that not many of the Guatemala people wore sunglasses. This could be an easy inexpensive solution to protect the eyes and hopefully delay a development of cataract.

According to data on prevalence of tobacco use from year 2009 the prevalence are higher in Guatemala than in Barbados, but lower than in Mexico for both men and women older than

15 years old (World Health Organization, 2002). Smoking increases the risk of development of cataract.

The participants in this study have low incomes and because of that the food they eat might not contain all the nutrition the body needs (Leske et al., 1991). Antioxidant insufficiency in the food is a risk for cataract (Grosvenor, 2007). This might be a part of the explanation with higher prevalence of cataract in this study compared to other studies in other countries. Also the fact that almost all participants in this study were non-whites, they were brown people, can be a part of the higher prevalence of cataract (Leske et al., 1991).

Figure 4.6 shows that participants with more lens opacities have lower VA, like the study of Marmamula 2013. But participant's with good VA can have a high grade of opacities in the red reflex and vice versa participants with small amount of opacities can have low VA. Consequently before performing cataract sugery it is important to listen for participants visual symptoms and not only trust clinical findings.

Aided VA could have been better in this population if a sphero-cylindrical subjective refraction was performed. But because of limited time and only trial lenses as equipment, examinations were made binocular and no cylinder components were estimated in this study. Our results with the eye examinations and the distribution of previously worn glasses in average gave all participants two more lines of vision.

More and more people suffer from cataracts, as people live longer (WHO, 2013). To reduce visual impairment caused by cataract the cataract surgery rate must be greater than the incidence rate of cataract (Shan et al., 2011). One problem with surgeries in developing countries can be the after-care and the risk for complications is higher in countries with poor hygiene situations.

Today surgery is the only way to treat cataract. An alternative in the future would be to find a way to delay the formation of the lens opacities, may be with some form of UV-filter, or to find an even more available and easier way of cataract surgery.

6 Conclusion

The prevalence of cataract was 28.6% and this population had an earlier development of cataract compared to previous studies. This could be due to the UV-radiation, the temperature and nutrition and antioxidant insufficiency. Also this study showed a highly significant correlation between age and grade of lens opacities and a low, but significant, correlation between aided VA and grade of lens opacities.

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Appendix

1.1 Clinic report

Date/Fecha:___________ **F♀:**______ **M♂:**______ **Read/Leer:**__________	**Vision For All** **Vision Para Todos, Suecia** **Guatemala, 2013** Nr.	**Work/Trabajo:**________ **Fuera** ☐ **o Dentro** ☐ **De cerca** ☐ **o Distancia** ☐
Name/Nombre:____________________________________		**Age/Edad:**____________
Fri / Hab.visus: OD:_______ OS:_______ OA:________ **Refraktion:** OD: sf________ cyl________ ax________ Visus:_______ OS: sf________ cyl________ ax________ Visus:_______ Add:_________ **Ordination:** Dist:________ Near:________ Bifo:_______		**Pinguecula:** **H:**______________ **V:**______________ **Pterygium:** **H:**______________ **V:**______________ **Cataract:** **H:**_____/_____/_______ **V:**_____/_____/_______
Anamnes:_______________________________________ ____		**Optiker:** ____________________

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