OULUN AMMATTIKORKEAKOULU

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THE GUIDELINE ADHERENCE OF OPTOMETRISTS WHEN ASSESSING AND REFERRING A PATIENT WITH PRIMARY OPEN-ANGLE GLAUCOMA

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ABSTRACT

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Glaucoma is a group of diseases that will lead to blindness if left untreated. With early detection, treatment, patient education, and referral for consultation or treatment by an ophthalmologist when indicated it is possible to reduce the risk of vision loss. For this reason, the knowledge of the disease and the right assessment and examinations are essential to optometrists who create a broad network of eye health professionals in Finland. Guidelines provide evidence-based knowledge regarding all aspects of glaucoma care. The purpose of the clinical guidelines for optometrists is to provide appropriate examination and treatment protocols.

The purpose of this master's thesis was to improve the knowledge of Finnish optometrists about the assessment of primary open-angle glaucoma (POAG) patients. This thesis contains two sections: integrative literature review and the development of a guideline. The purpose of the research section was to map optometrists' adherence to glaucoma guidelines. The aim was to observe changes in performing comprehensive eye examinations and to discover the factors that affect the adherence. The purpose of the development section was to create a guideline for Finnish optometrists about POAG patients' assessment. The development of the guideline was based on pre-existing glaucoma guidelines, integrative literature research, and a workshop development method.

The integrative literature research revealed high compliance to visual acuity measurements, biomicroscopy of the anterior segment, intraocular pressure measurements and optic nerve head assessment. Adherence was low in performing gonioscopy and with the use of the Goldman applanation tonometry. Glaucoma guidelines did increase the adherence to the applanation tonometry, optic disc evaluations and imaging, and the accuracy of the right susception of POAG patients which led to earlier diagnosis and management. Education, feedback, a team care model, and pre-designed assessment sheets were found to be aspects increasing adherence. These are also the aspects to consider when implementing the Finnish glaucoma guidelines.

The education of the optometrists is a key factor that will increase compliance with new guidelines. Knowledge of the disease and the existing guidelines with a user-friendly guideline will improve the optometrists' skills and compliance with high-quality examinations and referrals. With Finnish laws and regulations, it is important to notice the importance of cooperation with ophthalmologists when creating guidelines and determining the threshold values for referring patients. Open discussion and new ways of thinking and organizing eye health services will benefit the scope of eye health and lead to high-quality services.

Guideline adherence, optometrists, primary open-angle glaucoma

CONTENTS

1 INTRODUCTION

Glaucoma is a global disease that can cause blindness if left undiagnosed or untreated. Is it estimated that over 76 million people have glaucoma worldwide in 2020 and the number is predicted to increase to 111,8 million in 2040 (Tham et al., 2014). Because of the high prevalence and asymptomatic nature of the disease, glaucoma is the second leading cause of worldwide blindness. (Quigley, 2011). As a progressive disease, the costs of glaucoma will increase as the disease develops. The costs of illness can be reduced if disease progression is prevented by early diagnosis and treatment. For glaucoma, there isn't any cost-effective screening test, but it is still important to detect high-risk patients for early treatment. In addition, patient compliance with therapy will affect the progression of the disease and the costs of illness. (Fiscella et al., 2009.) Thus all eye health professionals must have strong evidence-based knowledge about POAG.

In Finland, there are almost 700 optician stores located around the whole country (Näe ry, 2023). This broad network creates easy and relatively low-cost access to optometrists' eye examinations which lead to the fact that they are often the first eye health professional for people to meet. This makes it important for optometrists to be aware and recognize any signs of eye diseases, such as glaucoma. There aren't any official and generally accepted guideline for optometrists to assess patients with POAG and the knowledge of the disease tend to vary due to different educational backgrounds of the optometrists.

The diagnosis and assessment of glaucoma is difficult, and it must be remembered when the examiner states that the eyes are healthy, they are diagnosing. Hollands et al. (2013) point out that the examiner must be sure that the presence of glaucoma is excluded when the findings are absent or not noticed by the examiner. The solution for these uncertain cases is not to refer them all to an ophthalmologist as it increases their burden. Hollands et al. (2013) suggest that increased access to high-quality periodic eye examinations with specific assessments of the IOP and optic nerve especially to patients with older age or other risk factors would improve the detection of glaucoma cases among the general population (Hollands et al., 2013). It should be considered whether the optometrists in Finland could be the actor who delivers more specific examinations to high-risk glaucoma patients. With better knowledge, high quality examinations and high adherence to clinical guidelines the optometrists would recognize the glaucomatous changes and the need for a visit to

an ophthalmologist for early diagnosis and management. This although requires cooperation, agreements, and education for all professionals.

Clinical guidelines are made to aid healthcare personnel's decision-making, increase quality, and reduce inappropriate variations in practice (Alderson & Maconachie, 2018). In the United Kingdom, the introduction of the NICE guidelines led to an increase in referrals to the hospital for raised IOP alone. According to the study made by Ratnarajan et al. (2013), the percentage of these moderately raised IOP referrals was 75 % in 2011 and the discharge rate of these referrals was up to 64 %. Different recommendations and guidance are made after that to reduce the referral rates to hospitals while maintaining the quality of patient care. (Ratnarajan et al., 2013.)

The idea of the master thesis arose from the order that the Finnish Ethical Council of Optometry (OEN) made from Oulu University of Applied Sciences in 2020 when guidelines for assessing different eye conditions were asked to conduct as master thesis projects. This master thesis is delivered to OEN and they have the right to utilize and edit the end product of the thesis. Personal motivation arises from the work made with patients with glaucoma together with ophthalmologists and surgeons.

The purpose of this master's thesis is to improve the knowledge of Finnish optometrists about the assessment of primary open-angle glaucoma patients and enhance the statement of the results from optometrists to ophthalmologists. The aim of the thesis is to produce evidence-based information about the effects of the clinical guidelines when assessing a POAG patient. Although Finnish optometrists don't have the right to refer patients straight to public eye health care units, the results of the optometrist's examination and the reason for the recommendation to an ophthalmologist's examination must be comprehensive and justifiable. With better knowledge, proper instruction and better performance optometrists can lighten the burden of the health care caused by the aging population.

This thesis contains two sections: integrative literature review and the development of a guideline. The purpose of the integrative review is to map the guideline adherence of optometrists when assessing and managing patients with primary open-angle glaucoma. The aim is to observe changes in performing comprehensive eye examinations and to discover the factors that affect the adherence.

The purpose of the development section is to create a guideline for Finnish optometrists about primary open-angle glaucoma patients' assessment and management. The aim of the research-assisted development is to utilize development action that includes participation to gather participants' ideas and thoughts about the guideline and utilize them when creating the blueprint of the guideline. Also, the educational and juridical aspects of the Finnish optometry field will be discussed in the thesis. With a guideline that considers all the aspects of adherence, the Finnish optometry scope, and current clinical protocols, it is possible to improve the quality level of the assessment, the management, and the referrals that Finnish optometrists do.

2 OPTOMETRISTS, PRIMARY OPEN-ANGLE GLAUCOMA, AND GUIDELINES

2.1 The framework for optometrists in Finland

To work as an optometrist in Finland one must complete the Bachelor of Health Care (Optometry) degree and have a license to practice as an optician granted by the National Supervisory Authority for Welfare and Health, Valvira. The education is 210 credits, and it permits optometrists to prescribe diagnostic drugs such as mydriatics and anaesthetics. Education includes studies about the anatomy and physiology of the eye and the pathology of the eye. Besides these studies, students will gain knowledge about general anatomy and physiology, and pharmacology. (Metropolia, 2023; Oulun ammattikorkeakoulu, 2023.)

The role of an optometrist is legislated by the Act and Decree on Health Care Professionals (*Asetus Terveydenhuollon Ammattihenkilöistä 564/1994*, 1994; *Laki Terveydenhuollon Ammattihenkilöistä 559/1994*, 1994). According to §16 in this act, the legislated optician can't independently prescribe glasses to

1. children under eight years old
2. a patient who has undergone an orbital surgery
3. a patient who apparently has an eye disease
4. patient with declined vision acuity.

Healthcare professionals must also use commonly accepted procedures and maintain their knowledge via updating education (Laki Terveydenhuollon Ammattihenkilöistä 559/1994, 15 §, 1994). They can start the treatment in accordance with their education, experience, and job description (Laki Terveydenhuollon Ammattihenkilöistä 559/1994, 23a §, 1994) but it is the licensed physician, who decides on the medical diagnosis and treatment of a patient (Laki Terveydenhuollon Ammattihenkilöistä 559/1994, 22 §, 1994).

By these laws, the National Supervisory Authority for Welfare and Health has made a statement about the work distribution of opticians and ophthalmologists. According to this statement, the optician is obliged to send the patient to an ophthalmologist when signs or symptoms of disease exist. (Valvira, 2019.) According to the act on the status and rights of patients, the patient has the right to

be informed about their state of health and treatment (*Laki Potilaan Asemasta Ja Oikeuksista 785/1992*, 1992).

World Council of Optometry (WCO) has made a Global Competence-Based Model of the Scope of Practice in Optometry that divides the scope of practice into four categories depending on the tasks, skills and knowledge, and performance. It describes what's the minimum competence level for healthcare professionals to call themselves an optometrist. (Kiely Optometry Australia, 2015.) In Finland, the Finnish Association of Vision and Eye Care (Näe ry) has stated that their will is to have the competence of a Finnish optometrist to category 3: Ocular Diagnostic Services (ODx) (Näe ry, 2017).

With patient examination, this includes formulating and implementing an examination plan based on the patient's history and using diagnostic pharmaceuticals when necessary. ODx optometrists should have the ability to assess the anterior and posterior segment of the eye as well as ocular media, to use applanation tonometry and corneal thickness tests. OCT and photography are supposed to be used in category 3, but using gonioscopy is classified into category 4. The differences in recommended abilities between categories when assessing the eye from the glaucoma assessment view are listed in table 1.

TABLE 1: Abilities when assessing the eye in different competence-based categories. (Table: Outi Saarikivi after Kiely Optometry Australia, 2015.)

Category 2: Visual Function Services (VF) The professional has the ability to use and interpret results from techniques such as, but not limited to:	Category 3: Ocular Diagnostic Services (ODx) The professional has the ability to use and interpret results from techniques such as, but not limited to:	Category 4: Ocular Therapeutic Services (OTx) The professional has the ability to use and interpret results from techniques such as, but not limited to:
tonometry	applanation tonometry	applanation tonometry gonioscopy
tests measuring the corneal contour	tests measuring corneal contour and thickness anterior segment imaging	tests measuring corneal contour and thickness anterior segment imaging

interpret results from diagnostic imaging technologies	interpret results from diagnostic imaging technologies	interpret results from diagnostic imaging technologies such as, but not limited to ultrasonography.
direct ophthalmoscopy	direct and indirect ophthalmoscopy	direct and indirect ophthalmoscopy
slit-lamp biomicroscopy	slit-lamp biomicroscopy and funduscopy	slit-lamp biomicroscopy and funduscopy
	diagnostic pharmaceuticals e.g. mydriatic agents	diagnostic pharmaceuticals e.g. mydriatic agents
Amsler grid test	Amsler grid test	Amsler grid test
	OCT	OCT
Interpret results from photography.	interpret results from investigations such as, but not limited to diagnostic imaging (e.g. HRT) and photography.	interpret results from investigations such as, but not limited to diagnostic imaging (e.g. HRT), ultrasound, and photography.

Differences between categories 2 and 3 regarding diagnosis and management are that in category 3, an ODx optometrist uses literature and research evidence to evaluate the expected prognosis of the condition and to design a management plan considering the practitioner's clinical expertise. They are also capable to organize and perform review visits as the patient's clinical condition indicates. (Kiely Optometry Australia, 2015.)

ODx optometrists can make recommendations for over-the-counter pharmaceuticals and monitor the patient's response to therapeutic management, but they can't prescribe medicines. Optometrists in all categories can make referrals for further investigation or management when the personal limitations of the optometrist are achieved. In addition, ODx optometrist manages patients jointly with other health-care practitioners, provides pre-operative assessment and advice in co-operation with ophthalmologists as well as post-operative follow-up assessment according to the surgeon's requirements. (Kiely Optometry Australia, 2015.)

2.2 Primary open-angle glaucoma

Glaucoma is a group of diseases that lead to irreversible blindness if not treated. It is associated with the loss of retinal ganglion cells, thinning of the retinal nerve fibre layer, and cupping of the optic disc. The disease is painless and asymptomatic until the late phase and it is estimated that even in the developed countries, half of the glaucoma cases are undiagnosed. Lowering the intraocular pressure (IOP) is the primary modifiable risk factor, although the IOP in open-angle glaucoma is often in the normal range. (Jonas et al., 2017; Quigley, 2011.)

Glaucoma can be divided into sub-categories open-angle and angle-closure glaucoma (figure 1). In the former form, the anterior chamber angle is open, and aqueous humour can flow without obstacles into trabecular meshwork and Schlemm's canal whereas (figure 2), in the latter form, the peripheral iris blocks the aqueous outflow by iridocorneal contact. Open-angle glaucoma can further be divided into primary and secondary glaucoma. In secondary open-angle glaucoma, the outflow facility of the aqueous humour is decreased due to a visible reason such as exfoliation or pigment, and in primary open-angle glaucoma (POAG), the anterior chamber angle is unmarkable. (Jonas et al., 2017.) POAG can be divided into normal tension glaucoma (NTG), where IOP is under 20 mmHg, and high-tension glaucoma (HTG), where IOP is over 21 mmHg (Vernazza et al., 2020).

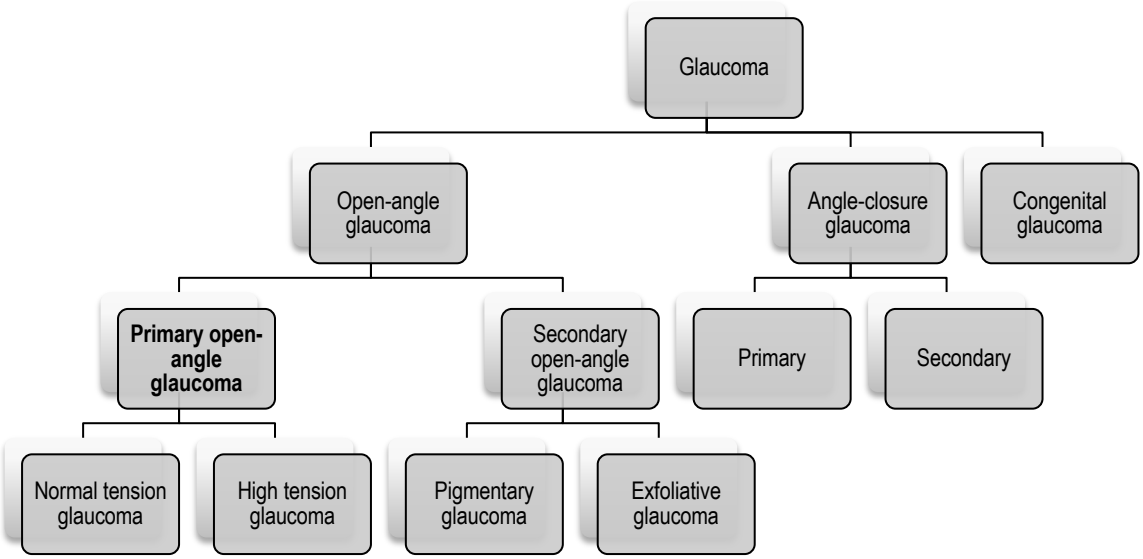

FIGURE 1: Sub-groups of glaucoma, simplified after Jonas et al. 2017 (figure: Outi Saarikivi)

According to the meta-analysis of Zhang et al. (2021), the prevalence of primary open-angle glaucoma worldwide has been stable for 20 years and it is estimated to be 2,4 % which means 68,56 million people (aged 40-80) worldwide. In comparison, Tham et al. (2014) estimate the prevalence of POAG to be 3,05 % globally in 2013 and increase by 75 % from 2013 to 2030 so that the number of cases would have been 76 million in 2020 and 111,8 million in 2040. In Europe, POAG is more common than primary angle-closure glaucoma and the number of POAG cases is estimated to be 9,21 million in 2020. The prevalence is higher among men than females and it increases with age. (Tham et al., 2014; Zhang et al., 2021.) No statistical differences are found among urban or rural areas, but there is geographical variation so that the prevalence is highest in Africa (4 %) and lowest in Oceania (1,8 %). In Finland, Laitinen (2009) has estimated that the prevalence of any type of glaucoma was 5 % within the Finnish population over 30 years old. Within patients with visual impairment, the prevalence of glaucoma is 8 % (Ojamo & Tolkkinen, 2020). Medication for glaucoma was prescribed and compensated for approximately 86 300 patients in Finland in 2022 (Kelasto raportti, 2023).

2.2.1 Pathophysiology

In primary open-angle glaucoma, the aqueous humour flows without obstacles from the ciliary body in the posterior chamber to the trabecular meshwork (TM) and Schlemm's canal in the anterior chamber angle (figure 2).

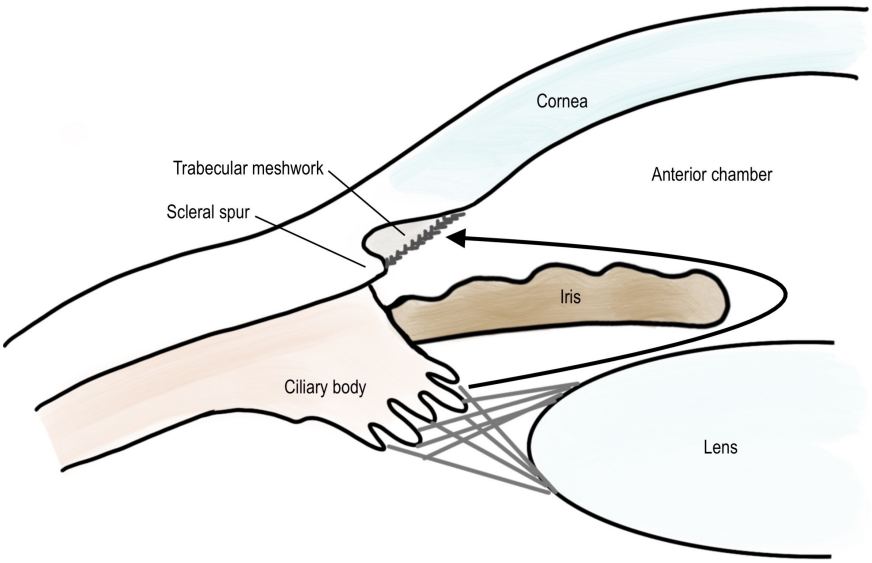

FIGURE 2: Anterior angle (figure: Outi Saarikivi)

POAG is considered to be an optic neuropathy where retinal ganglion cells go through a gradual apoptotic death leading to loss of neuroretinal rim increasing the cup-disk ratio of the optic nerve head (ONH). In POAG even the normal levels of IOP can cause damage to the optic nerve head, leading to a condition called normal-pressure glaucoma. (Jonas et al., 2017.) There are differences in the pathophysiology of normal tension glaucoma (NTG) and high-tension glaucoma (HTG). In NTG, early ONH damage is triggered by a higher rate of hemodynamic crisis, low systemic blood pressure, and low ophthalmic blood pressure. In HGT, the changes in the TM structure - caused by mainly oxidative stress, but also ageing and genetic changes as well as environmental and endogenous factors - decrease its flexibility, and when the changes become chronic, aqueous humour drainage resistance increases and IOP elevates. (Vernazza et al., 2020.)

Two complementary theories explain the impact of IOP in the pathogenesis of glaucoma. The vascular theory suggests that the compression of capillaries caused by progression in IOP, oxidative stress, or systemic levels of vasoconstrictive peptides leads to impaired blood flow to ONH and eventually to chronic ischemic injury of the optic nerve. The mechanical theory explains normal-pressure glaucoma and suggests that the compression of axonal fibres of retinal ganglion cells at the lamina cribrosa or optic nerve head develops optic neuropathy. Compression can be due to chronic IOP increase or high trans-lamina cribrosa pressure difference due to abnormally low cerebrospinal fluid pressure. (Evangelho et al., 2019; Vernazza et al., 2020.) Further theories have been developed to explain the role of trabecular meshwork (TM) in the pathogenesis of glaucoma. These theories suggest that the progressive loss of TM cellular integrity release proteins into the aqueous humour and these proteins work as a pro-apoptotic signal for retinal ganglion cells and their axons in the ONH. (Vernazza et al., 2020.)

As a neurodegenerative disease, glaucoma affects retinal ganglion cells (RGC) and later intracranial optic nerve and the lateral geniculate nucleus (LGN). It is hypothesized that reactive oxygen species (ROS) or disturbances in the mitochondrial dynamics lead to apoptosis and block axonal transportation. This leads to neurotrophic signal deprivation, RGC death, and optic nerve atrophy. In LGN, reduced mitochondrial activity and shrinkage of neurons with smaller nuclei are found in glaucomatous brains. In the visual cortex, degeneration is detectable after at least 50 % of the RGC is lost. (Vernazza et al., 2020.)

2.2.2 Signs and symptoms

Patients with primary open-angle glaucoma don't usually present any symptoms until the disease progresses to later stages of the disease and visual field loss affects the central vision. Advanced visual field losses make it more difficult to perform specific visual tasks such as searching objects within a visual scene, navigating, and reading. (Optometry Australia, 2020.) Because of the absence of subjective symptoms, the assessment of the visual field and optic nerve head is required in the first visit and changes in these should be suspected as glaucoma (Biggerstaff, 2020; Hollands et al., 2013). Side effects and inconvenience of the medication is more frequent symptom or complication that glaucoma patients report (Fingeret et al., 2010).

2.2.3 Risk factors

As mentioned, patients don't complain about visual symptoms until the late phase of POAG. For this reason, it is important to pay attention to accurate anamnesis and the patient's ocular history. That way it is possible to detect those individuals who are potentially at risk of glaucoma and need more specific examinations. (Biggerstaff, 2020.) The risk factors for different types of glaucoma are partly the same (Jonas et al., 2017). This chapter discusses the risk factors of POAG and glaucoma in general but not those of angle-closure glaucoma.

The risk factors for glaucoma include a history of raised IOP, age over 80 years old, black race, positive family history (in a first-degree relative), and myopia. Possible risk factors are systemic cardiovascular disease, diabetes, migraine, hypertension, and vasospasm. Studies have also found correlations between glaucoma and obesity, current smoking, alcohol, stress, anxiety, and sleep apnea but the strength of evidence tends to vary or be weak. (Biggerstaff, 2020; Hollands et al., 2013; Worley & Grimmer-Somers, 2011.)

Intra-ocular pressure (IOP) is the most important risk factor for POAG, says Hollands et al. (2013), but they also remind that as a single diagnostic test, the measurement of IOP is deficient. Because a low IOP does not rule out glaucoma, it can't be used for screening or case detection. Studies have shown that the risk for glaucoma increases exponentially as IOP increases. Individuals with IOP 20–23 mmHg have a 4 times greater risk compared to individuals with IOP below 16 mmHg. The risk increases to 10 times when the IOP is 24 mmHg or greater and to 40 times with an IOP of

30 mmHg or greater. The risk of progression increases by 10% with every 1mmHg increase in IOP. (Worley & Grimmer-Somers, 2011.) Asymmetric level of IOP between eyes correlates with asymmetric damage to the optic nerve (Fingeret et al., 2010).

The prevalence of open-angle glaucoma is elevated among **individuals of the African continent** compared to the Caucasian population (Worley & Grimmer-Somers, 2011). The prevalence is found to be up to three times greater. The reason is explicated by smaller trabecular meshwork height which may lead to diminished outflow facility. In addition, thinner central corneal thickness among the African population is thought to be one explanation for greater prevalence. (Zhang et al., 2021.)

Advanced age increases the risk for glaucoma. When comparing age groups of 40–50 to 80 years and older, the risk for glaucoma was 10 to 17 times higher among the elderly group. The prevalence of open-angle glaucoma increased from 0,3–1,1 % in individuals aged 40 years to 3,3–9,2 % in individuals aged 70 years. (Worley & Grimmer-Somers, 2011; Zhang et al., 2021.) Aging is associated with higher IOP and **thinner central corneal thickness** which in turn increase the prevalence of glaucoma (Zhang et al., 2021).

If **a patient's close relative has glaucoma**, they are 3 to 6 times more likely to have the disease themselves too. The strongest association is found between siblings. However, most of the studies examine this by verbal reporting rather than clinical examination and for this reason, the association shouldn't be concerned unquestioningly. (Worley & Grimmer-Somers, 2011.) Several genes are found to be associated with primary open-angle glaucoma but the effect of the gene mutation on encoded protein and finally its function is unclear. Founded alleles do not solely have an association with intraocular pressure but they are also associated with central corneal thickness and optic disc size. It is found that the alleles that have an association with glaucoma in the white population have a weaker association in the African-American population. (Jonas et al., 2017.)

According to the meta-analysis by Wu, Hao, Du, Cao, Lin, Sun, Xie and Wang (2021), **myopia** may be a risk factor for POAG by the odds ratio (OR) of 2,26. The OR was bigger in high myopia compared to mild myopia. The writers suspect that it might be due to two reasons. First, myopia could damage the function of the trabecular meshwork leading to increased resistance of aqueous humor flow. Second, the optic nerve head may be more sensitive to normal IOP levels, and apparently, normal pressure can cause neural tissue strain leading to the loss of ganglion cells.

Studies have shown that patients with **systemic hypertension** have a 1,71-fold risk of developing glaucoma compared with non-hypertensive patients. This is explained through two different mechanisms. First, the increased pressure in the capillary in the ciliary body leads to an increase in the production of aqueous humour. Second, an increase in episcleral venous pressure, which obstructs the return flow of aqueous humour, leads to a decrease in the absorption of aqueous humour. It has also been stated that glaucoma damage could occur due to the ischemic optic nerve of retinal ganglion cells. This could be caused by decreased perfusion in the posterior segment of the eye due to either atherosclerosis, decreased central retinal artery calibre, or autoregulatory dysfunction caused by increased production of endothelin-1. Studies have also explained that unstable diastolic blood pressure can increase the risk of open-angle glaucoma. (Nislawati et al., 2021.)

When assessing the progression of POAG, it is important to consider the risk factors for rapid progression. These include older patients who had decreased mean deviation to their visual field testing and a greater vertical cup-to-disc (C/D) ratio at baseline. (Biggerstaff, 2020.) Divergent opinions are made about the relationship between myopia and glaucoma progression. In a meta-analysis made by Wu et al. (2021), there was OR 0,85 between myopia and the progression of primary open-angle glaucoma. This result is inconsistent with previous studies. Adherence to treatment is related to the progression of the disease and thus patient's socioeconomic status is associated with the progression of the disease (Jonas et al., 2017)

2.2.4 Examination and imaging

Biggerstaff (2020) suggests that patients with suspected POAG should be examined using a slit-lamp examination of the anterior segment, funduscopy, tonometry, gonioscopy, and pachymetry.

With the **examination of the anterior segment**, it is possible to indicate the risk factors for secondary glaucoma such as pigmentary dispersion syndrome, pseudoexfoliation, angle recession, uveitis, and evidence of trauma (Optometry Australia, 2020).

When **assessing the optic disc**, the following aspects should be considered: the size of the disc, health of the neuroretinal rim using the ISNT rule, presence of disc haemorrhages, peripapillary atrophy, or nerve fibre layer (NFL) defects. *The size of the disc* affects the C/D ratio so with a larger-

sized disc also the C/D ratio is larger and vice versa (Figure 3: a, b). *ISNT rule* states the thickness of the healthy rim: it is thickest in the inferior quadrant, followed by superior and nasal quadrants, and thinnest in the temporal quadrant. ISNT rule isn't a recommendable diagnostic tool because it gives false positive and false negative rates as high as 30 %. *Disc haemorrhages* (Figure 3: d) can indicate the progression of glaucoma. Disc haemorrhages appear linear in shape and perpendicular to the disc margin. Length can be variable, but they should be located within one disc diameter from the disc margin. Disc haemorrhage alone is insufficient for diagnosing glaucoma hence they can be found also in non-glaucomatous eyes. Haemorrhages precede RNFL loss and re-examination after the haemorrhages have resolved will reveal if changes have resulted. (Optometry Australia, 2020.) It should be recalled that the absence of disc haemorrhages does not rule POAG out (Hollands et al., 2013).

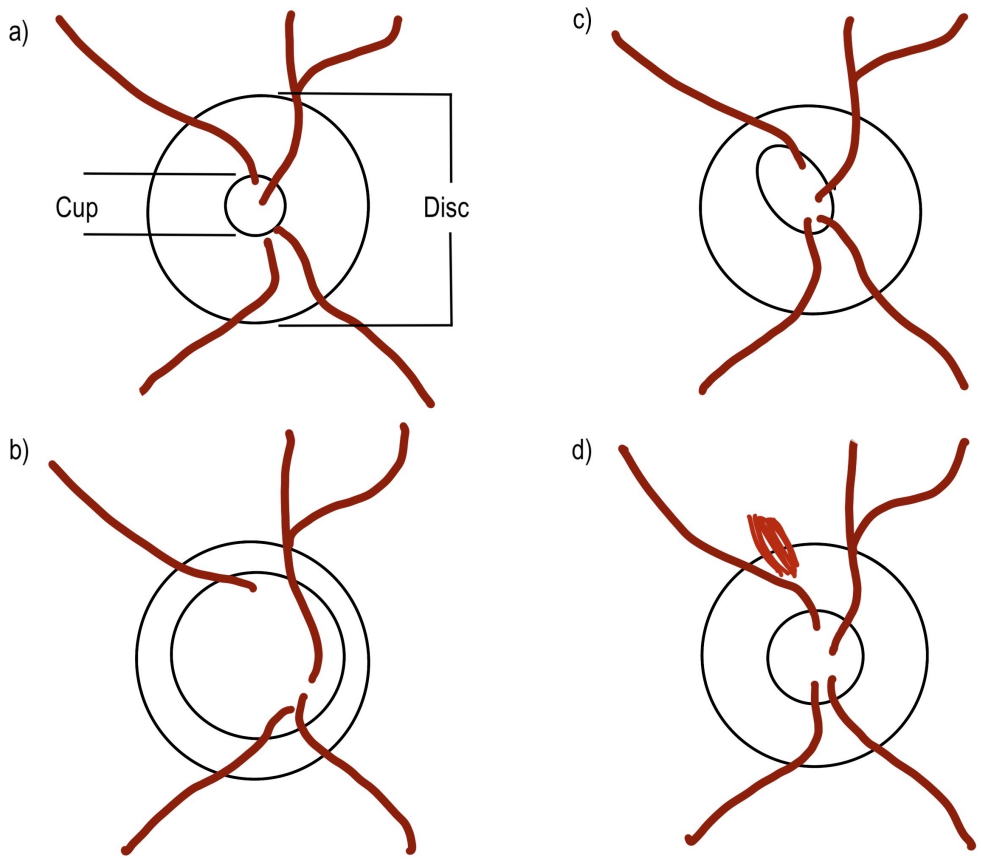

FIGURE 3: a) a healthy OHN with a small C/D ratio, b) an optic disc with a large C/D ratio, c) an optic disc with RIM loss superior-temporarily, d) an optic disc with disc haemorrhages. (Figure: Outi Saarikivi)

Peripapillary atrophy is more common in glaucomatous eyes than in healthy eyes. Although studies have shown that atrophy in zone beta (bordering the optic nerve head) is more frequently seen in progressive glaucoma, it isn't a useful marker for detecting glaucoma progression due to its low frequency. (Fingeret et al., 2010; Optometry Australia, 2020.) *The loss of the retinal nerve fiber layer* increases the size of the optic cup, relative to the disc diameter. This is called optic nerve cupping and increased cup-to-disc ratio. Cupping can be assessed by slit lamp or direct ophthalmoscopy, stereoscopic disc photographs, or specialized diagnostic tests measuring the thickness of the nerve fibre layer. Direct ophthalmoscopy can presumably be found in every optic store, and it is useful in visualizing disc haemorrhages, but the optic disc is seen only in a two-dimensional view. Thus, using slit lamp ophthalmoscopy with pharmacologic dilation is recommended to assess the glaucomatous disc. Studies use the cup-to-disc ratio of 0.7 and cup-to-disc asymmetry of 0.3 or greater as a threshold for glaucomatous cupping. However, a more normal cup-to-disc ratio does not exclude POAG. (Hollands et al., 2013.)

For **intraocular pressure measurement**, the Goldmann applanation tonometry (GAT) is the gold standard, but researchers point out the effect of the corneal properties that may decrease the accuracy of the tonometer (Biggerstaff, 2020). Goldmann applanation tonometry assumes an average central corneal thickness of 520um. Central corneal thickness (CCT) should be measured with **pachymetry** on patients with glaucoma or glaucoma suspect because significant variation in CCT has been reported in the meta-analysis. Asymmetry of the CCT between eyes should be noticed since studies have shown that a thinner cornea is at greater risk for developing visual field loss. For this reason, a thinner CCT is also an independent risk factor for POAG because it results in an underestimation of the IOP. (Fingeret et al., 2010; Optometry Australia, 2020.)

IOP tends to fluctuate during the day and measuring IOP multiple times at various times of the day may help to evaluate diurnal variability. IOP tends to rise during the nocturnal hours and peaks just around awakening. (Fingeret et al., 2010.) Higher fluctuations may be associated with a higher risk of progression, but the evidence from the studies is inconclusive (Optometry Australia, 2020). An IOP of 22 mmHg or higher is assumed to be the threshold in most of the studies and it is a commonly accepted value to divide normal-tension glaucoma and high-tension glaucoma (Hollands et al., 2013). IOP alone is not diagnostic for glaucoma as glaucoma can develop at any IOP level (Optometry Australia, 2020).

Gonioscopy should be performed to differentiate an open angle from a closed angle and primary glaucoma from secondary ones (Fingeret et al., 2010). Normally, the superior anterior chamber tends to be the narrowest. Also, aged patients and female patients tend to have narrower angles compared to young individuals or men. Although anterior chamber angle narrowing tends to be more rapid amongst Chinese individuals, no consistent evidence is found between racial differences in gonioscopic grades. (Optometry Australia, 2020.)

Fundus photographs and imaging studies are used to diagnose and evaluate the progression of glaucoma based on the baseline situation. Suggested imaging studies include fundus photography, retinal nerve fibre layer (RNFL) imaging using red-free filters, and optical coherence tomography together with standard automated perimetry. Also, fluorescein angiography, ocular blood flow analysis, colour vision measurements, contrast sensitivity testing and electrophysiological tests can be used, but they are not included in routine examination protocols. For examination of the optic disc and the thickness of the nerve fibre layer, confocal scanning laser ophthalmoscopy (eg. HRT III), scanning laser polarimetry (eg. GDX) and optical coherence tomography (OCT) are used. (Biggerstaff, 2020.)

It is recommended to use automated **visual field (VF) testing** when evaluating visual field defects and to compare the results with the reference values from an age-matched control population. Abnormalities in the visual field will be seen when as many as 40 % of the axons are lost. (Fingeret et al., 2010; Hollands et al., 2013.) Typical visual field defects in glaucoma follow the anatomy of the optic nerve head and retinal nerve fibre layer and the patterns of defects are called nasal step, arcuate, paracentral, and centrocaecal (figure 4). Possible but rare defects are enlarged blind spots and temporal defects. (Optometry Australia, 2020.)

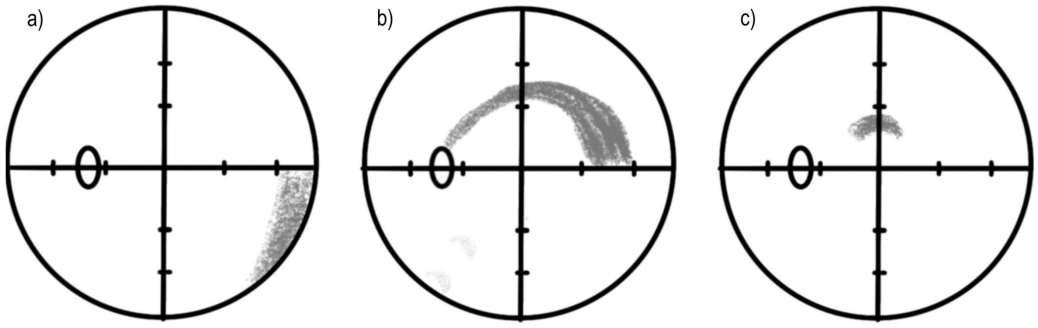

FIGURE 4: Examples of glaucomatous visual field defects. a) nasal step, b) arcuate c) paracentral (figure: Outi Saarikivi)

With imaging and VF examination, it is important to note that the results may vary and fluctuate between instruments, and thus testing results should be combined with structural and functional examination results. The combination of OCT and VF examination together with findings in the eye examination predict the loss of retinal ganglion cells more precisely than either measure alone. (Biggerstaff, 2020.)

2.2.5 Diagnosing and management

Diagnosis of primary open-angle glaucoma is based on glaucomatous changes at the optic nerve head and retinal nerve fibre layer assessed with ophthalmoscopy and imaging techniques such as OCT (Jonas et al., 2017; Quigley, 2011). These changes include enlargement of the optic cup due to the loss of the neuroretinal rim, development, and enlargement of the peripapillary beta zone, thinning of the RNFL, and optic disc haemorrhages. The more optic nerve fibres are lost, the deeper the visual field defects. For this reason, perimetric visual field examination is good for diagnosis and follow-ups as it detects the progression of the disease. (Jonas et al., 2017) With regularly repeated visual field tests it is possible to assess the reaction to IOP-lowering treatment (Quigley, 2011). Although Goldmann applanation tonometry is the gold standard for measuring intraocular pressure (Biggerstaff, 2020), IOP isn't a main criterion for POAG diagnosis though it is an essential part of the diagnosis. Gonioscopy is used to differentiate open-angle glaucoma from angle closure glaucoma as well as primary glaucoma from secondary ones. (Jonas et al., 2017.)

Lowering the intra-ocular pressure is the only generally accepted treatment to prevent glaucoma from further progression as it is found to be effective in preventing the progression of glaucoma regardless of the baseline pressure. Lowering the pressure can be done with pharmacological treatments, laser therapy, or surgery. (Jonas et al., 2017; Quigley, 2011.) With pharmacological treatment, adherence to regular medication is essential in preventing progression of the vision loss while laser treatment is found to have the least side effects and minimum risks compared to the other two treatment choices (Quigley, 2011). The IOP is lowered to the level where further progression is unlikely, and it is set individually. Usually, the reduction is 20–50 % depending on the pre-existing optic nerve damage and risk factors present so that patients with greater damage have lower target pressures than those with milder glaucomatous changes or risk factors for progression. (Jonas et al., 2017; Quigley, 2011.) The target level is supposed to be reanalysed during the follow-

up visits by assessing whether the stage of the disease is stable or has progressed. (Jonas et al., 2017.)

Pharmacological management of open-angle glaucoma includes prostaglandin analogs which are the first-choice eye drops because of their efficiency at lowering IOP and controlling IOP fluctuations. Depending on the agent, the reduction of IOP can be up to 27-35 %. Their unwanted side effects are primarily cosmetic, such as changes in eyelashes. For second-choice or unilateral treatment, beta-blockers are considerable although they have a relatively high incidence of side effects. Other choices are carbonic anhydrase inhibitors and alpha agonists. They should be considered as monotherapy if a patient has an intolerance to prostaglandin analogues or contraindication to beta-blockers i.e. asthma or chronic obstructive pulmonary disease (COPD). Alpha agonists are also used as a complementary choice to beta-blockers. (College of Optometrists, 2022; Fingeret et al., 2010; Optometry Australia, 2020.) Rho-kinase inhibitors increase aqueous humor outflow through trabecular meshwork reducing IOP up to 20 %. Unwanted side effects include mild conjunctival hyperaemia. (Wang et al., 2021.) For sufficient control of IOP, multiple medications are often needed. Combination drops usually have no additional new side effects compared to monotherapy but have greater compliance than separate medication drops because the dosing is done less frequently from only one bottle. (Wang et al., 2021.)

Non-pharmacological treatments include Selective Laser Trabeculoplasty (SLT) which is increasing as a first-line treatment for open-angle glaucoma because of its cost-effectivity. The purpose of SLT is to increase the aqueous outflow and by that, it can reduce IOP. SLT seems to be more effective in high-tension glaucoma than with patients whose IOP is less than 14 mmHg. (College of Optometrists, 2022; Optometry Australia, 2020.) Surgical treatment for glaucoma includes lens extractions, minimally invasive glaucoma surgery (MIGS), filtration/incisional surgery, and tube shunts. (Optometry Australia, 2020)

2.3 Optometric Clinical Guidelines for Primary open-angle glaucoma

Four different guidelines for optometrists regarding the assessment and management of patients with glaucoma were evaluated to build a background for this development project and their content is discussed in this chapter. The guidelines developed by the American Optometric Association and by the College of Optometrists were chosen because of their high competence in the optometry

field. Glaucoma Clinical Practice Guide by Optometry Australia was chosen because it contains the collaborative aspect of managing patients with POAG. One national guideline for optometrist-ophthalmologist cooperation regarding glaucoma-patient assessment was included in the evaluation because it considers the laws and regulations of optometrists in Finland. The comparison form of guidelines is found in appendix 2.

In Great Britain, Clinical Management Guidelines were created after optometrists gained an independent prescribing status for prescribing any licensed medicine for conditions affecting the eye and tissues surrounding it within their recognized area of expertise and competence. The purpose of the guidelines was to support optometrists and safeguard patients. The guidelines are part of the evidence-based practice that includes patient preference as well as the optometrist's clinical expertise. (College of Optometrists, 2023.)

Guidelines provide evidence-based knowledge regarding all aspects of glaucoma care. The purpose of the clinical guidelines for optometrists is to provide appropriate examination and treatment protocols. With early detection, treatment, patient education, and referral for consultation or treatment by an ophthalmologist when indicated it is possible to reduce the risk of vision loss. With guidelines, it is also possible to lighten the burden of the limited ophthalmology resources so that ophthalmologists can be utilized in more advanced diseases. (Fingeret et al., 2010; Optometry Australia, 2020.)

2.3.1 Assessment

Whether the scope of an optometrist, it is essential in routine eye examination to detect those patients who are at risk of developing glaucoma. This includes investigation of risk factors, the structure of the anterior and posterior eye, IOP, and functional assessment such as visual acuity and visual fields. If glaucomatous changes or risk factors are discovered, a specific assessment is recommended. (Optometry Australia, 2020.)

A comprehensive eye and vision examination should include **visual acuity and evaluation of the pupils** to reveal the presence of a relative afferent pupil defect (RAPD). **Assessment of the cornea and anterior chamber** should be conducted to rule out secondary causes that increase the IOP. (Fingeret et al., 2010.) Ocular surface diseases can affect the efficacy of topical anti-glaucoma

medications or elevate the IOP measurements (Optometry Australia, 2020). The guidelines by Näe ry (2022), Optometry Australia (2020), and College of Optometrists (2022) included **assessment of the anterior chamber** by using the Van Herick method although the latter two suggested that all patients with narrow-angle (less or equal to 25%) or suspected glaucoma require gonioscopy. Anterior OCT is suggested to be used only as a complementary technique to the gonioscopic examination that lets the examiner visualize neovascularization and pigment of the angle (Optometry Australia, 2020).

Central corneal thickness was suggested to be measured when suspicion of glaucoma has arisen. This can be made with either a pachymeter (Fingeret et al., 2010) or anterior optical coherence tomography (OCT) (Optometry Australia, 2020). In the national guideline, also assessment of the tear film, Meibomian glands, eyelids, cataract, and vitreous is included in the eye health assessment (Näe ry, 2022).

IOP was suggested to be measured before pupillary dilation and gonioscopy using Goldmann tonometry. The time of the day and used instrument should be recorded. (Fingeret et al., 2010.) The national guideline approved rebound tonometer for measuring IOP (Näe ry, 2022).

The posterior segment biomicroscopy includes the **assessment of the optic nerve head** using slit lamp fundoscopy that provides stereoscopic visualization through a dilated pupil (Fingeret et al., 2010). The purpose of the optic nerve head assessment is to detect glaucomatous optic disc features but also to rule out other retinal pathology that may contribute to optic disc changes or visual field loss (Optometry Australia, 2020). The College of Optometrists (2022) states that a cup-to-disc ratio of 0.6 or bigger indicates glaucomatous optic disc cupping. However, Fingeret et al. (2010) and The Optometry Australia (2020) point out that there is no cutoff value for the C/D ratio that would predict the disease.

All the guidelines suggest **fundus photographing for documentation** or establishing the baseline. This is done with either posterior OCT or fundus stereo photography when available. **Visual field tests** are recommended to be done with standard automated perimetry. (College of Optometrists, 2022; Fingeret et al., 2010; Näe ry, 2022; Optometry Australia, 2020.)

2.3.2 Management and reviews

The management of a patient with primary open-angle glaucoma depends on the rights and permissions of optometrists in different countries. In Finland, the management, prescription, and reviews are made by ophthalmologists unless agreed otherwise among healthcare professionals (Näe ry, 2022).

College of Optometrists (2022) suggests that the management of a patient with primary open angle glaucoma should be done by a healthcare professional with a specialist qualification in glaucoma, relevant experience, or the ability to detect changes in clinical status. Anti-glaucoma medication shouldn't be prescribed without consultation with an ophthalmologist. In the guideline by Optometry Australia (2020), topical medication is considered to be the mainstay of treatment given by optometrists. AOA guideline (2010) includes patient education, continuity of care, compliance with therapy, and communication and co-management with other health care professionals as a part of POAG management. In all the evaluated guidelines, surgery is performed by ophthalmologists. (College of Optometrists, 2022; Fingeret et al., 2010; Optometry Australia, 2020.)

Monitoring and follow-up management can be done by an optometrist with a specialist qualification in glaucoma (College of Optometrists, 2022). AOA recommends that follow-up visits should be done at least yearly or if any complicating factors occur, more frequent visits should be considered. Follow-up examinations are similar to those done in the initial glaucoma evaluation and the purpose of these is to ascertain whether glaucoma is stable or progressing. If the latter, treatment should be adjusted. (Fingeret et al., 2010.)

2.3.3 Referrals to ophthalmologists

Three out of four guidelines included a section considering referrals from optometrists to an ophthalmologist. The Optometry Board of Australia (2020) suggests that an optometrist must do a referral to an ophthalmologist within four months of starting the treatment for glaucoma, or if the treatment doesn't stabilize the patient's condition or afflict side effects, or if the patient needs assessment for surgical intervention or laser treatment. The ophthalmologist then formulates an ongoing collaborative management plan agreed upon by the patient, optometrists, and ophthalmologist. The plan should be understood by all parties involved and clear communication is essential. If

the patient's condition requires laser treatments or surgical intervention, if their glaucoma is unstable, or if the patient suffers from the side effects of the medication, a referral to an ophthalmologist is required. (Optometry Australia, 2020.)

The guideline made by the College of Optometrists (2022) points out that optometrists "should recognize their limitations and where necessary seek further advice or refer the patient elsewhere". The ophthalmologist will confirm the diagnosis and determine the treatment plan for the patient. Repeated measurements and referral refinement are recommended before referring patients to a hospital.

National guideline made by NÄE ry (2022) instructs that the referral must be made if the IOP exceeds 21-24 mmHg considering the diurnal variability, or if the IOP between eyes exceeds 4mmHg without a known reason, or if asymmetry in optic nerve heads is found without knowing the reason or if disc margin haemorrhage is found.

The guideline for optometrists made by NÄE ry included information regarding the contents of the referral for ophthalmologists listed below:

- the reason for the visit
- Anamnesis
- Changes in refraction
- Finding and their location
- Suspected diagnosis using ICD-10 coding
- Fundus imaging and/or other documentation
- The level of urgency
- Contact details
- Request for feedback

The guideline made by the American Optometric Association didn't include a section regarding referrals to the ophthalmologist (Fingeret et al., 2010).

3 THE PURPOSE AND AIMS OF THE THESIS

The purpose of this master's thesis is to improve the knowledge of Finnish optometrists about the assessment of primary open-angle glaucoma patients and enhance the statement of the results from optometrists to ophthalmologists. The aim of the thesis is to produce evidence-based information about the effects of the clinical guidelines when assessing a POAG patient.

This thesis contains two sections: integrative literature review and the development of a guideline. The purpose of the integrative review is to map the guideline adherence of optometrists when assessing and managing patients with primary open-angle glaucoma. The aim is to observe changes in performing comprehensive eye examinations and to discover the factors that affect the adherence.

The research question of the integrative review is:

- How does an optometrist conform to glaucoma guidelines when assessing and referring glaucoma patients or suspected glaucoma patients?

The purpose of the development section is to create a guideline for Finnish optometrists about primary open-angle glaucoma patients' assessment and management. The aim of the research-assisted development is to utilize development action that includes participation to gather participants' ideas and thoughts about the guideline and utilize them when creating the blueprint of the guideline.

The research questions for the development section are:

- What are the procedures that should be included when a Finnish optometrist assesses a patient with suspected primary open-angle glaucoma considering the equipment, knowledge, and regulations of the Finnish optometric environment?
- What is the preferred model of the guideline, and can that be used as the referral table when referring the patient to an ophthalmologist?
- How to implement new guidelines and ensure their commissioning?

4 INTEGRATIVE REVIEW AS A RESEARCH METHOD

Integrative review summarises literature made from the topic of interest and draws overall conclusions from the sampling frame. It combines the results from different qualitative and quantitative research and as such, combines broader evidence than systematic reviews. To avoid subjectivity, bias, and lack of rigour that diversity of the sampling frame can bring, an integrative review must be made following the protocol made for integrative reviews. The protocol includes five phases that are discussed below and mirrored to this thesis. (Evans, 2007; Whittemore, 2007.)

4.1 Problem identification

Problem identification and review purpose formulation are the initial and the most important phases of integrative review. They define the focus of the review, form the basis of the inclusion criteria, and influence the analysis phase. Formulation of the review question limits the volume of the literature that must be screened to find the relevant studies. The review question must involve the population of interest, intervention, issue, problem, or phenomenon in the focus of the review.
The first phase also includes the formulation of the selection criteria. These criteria will define the scope and boundaries of the literature review and help avoid irrelevant information or the risk of bias. (Evans, 2007; Whittemore, 2007.)

The purpose of this thesis is discussed in chapter 3. The inclusion and exclusion criteria for the integrative review of the thesis are listed in table 2:

Table 2: Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Population	optometrists	ophthalmologists
Phenomenon	adherence to guidelines regarding primary open angle patients' assessment and management	adherence to guidelines regarding other eye conditions or practice patterns

Outcome or data of interest	compliance to guidelines, changes in methods, or referrals.	
Research designs		letter, comment, editorial
Language	English, Finnish	other languages
Geographical location	Europe, North America, Australia	Asia, Africa, and South America
Abstract and full-text	both available	neither available
Time frame	past 15 years	

The geographical location was decided based on the glaucoma guidelines that were evaluated in the theoretical section. The broad time frame in the inclusion criteria was based on the changes in optometry scope in Great Britain. In 2007, optometrists gained independent prescribing status for ocular conditions (Cope et al., 2016). With studies made 15 years ago, the license would still be a recent change, which could be the situation also in Finland if the intentions of Näe ry regarding the competence level of Finnish optometrists will actualize.

4.2 Literature research

To perform a representative sample of studies it is essential to have a well-defined search strategy that contains a careful selection of databases and search terms, selection criteria, and search strategies. Strategies include computerized database searching, searching reference lists, hand-searching relevant journals, and searching conference abstracts. (Evans, 2007; Whittemore, 2007.) It has been recommended to use a two-phase strategy that includes a preliminary search of databases to identify optimal search terms followed by a search that includes all identified search terms (Evans, 2007).

The purpose of the review, sampling frame, and the amount of data available define the appropriate sample size for an integrative review. A larger sample size increases challenges in analysis and synthesis. The delimitation of inclusion and exclusion criteria will reduce the large sample size, but the criteria must be methodically justified and made explicit. (Whittemore, 2007.)

The search strategy for this thesis was made using the help of an information technician from Oulu University of Applied Sciences because it has the potential to improve the specificity and comprehensiveness of the search (Whittemore, 2007). The preliminary search was done using the PubMed and CINAHL databases and searching MeSH terms and keywords concerning the review. In the preliminary research also MeSH terms such as “Guideline adherence” [mesh] in PubMed and subject headings, e.g. (MH "Practice Patterns") OR (MH "Practice Guidelines") in EBSCOhost, were used, but that reduced the sample size. Hence, only the keywords were used. The research question was divided into key concepts that were optometrist, glaucoma, guideline, and adherence. Synonyms for these keywords were found through brainstorming with an information technician, from thesauri, and by browsing preliminary search results. The groups of terms were combined to search strings using Boolean operators and the actual search was carried out on 5th April 2023. The result of the search is listed in table 3.

TABLE 3: Databases, search terms, and number of results

Database	Search terms	Results (number)
EBSCOhost; CINAHL with full text + MEDLINE	optometr* AND (glaucoma OR “glaucoma suspect”) AND (guideline OR "practice pattern") AND (adherence OR compliance OR commitment OR involvement)	33
PubMed	optometr* AND glaucoma AND (guideline OR "practice pattern") AND (adherence OR compliance OR commitment OR involvement)	30
Science Direct	(optometry OR optometrist) AND (glaucoma OR glaucoma suspect) AND (guideline OR "practice pattern") AND (adherence OR commitment OR involvement)	194
Medic	(optometr* OR optik*) AND (glaucoma OR glaukooma) AND (ohje* OR guideline)	0
		Total: 257 studies

The found studies (n = 257) were imported to the JBI Sumari systematic review tool (Munn et al., 2019) where studies were screened using the inclusion criteria to assess whether the found study was included or excluded. First, the studies were screened by name and abstract, and all that met the exclusion criteria were excluded. This ruled out all the studies and articles concerning other eye conditions than glaucoma, the ones that didn't have an abstract nor full text, and studies that didn't concentrate on guidelines. Also, most of the duplicates were excluded in the first screening phase. After screening titles and abstracts, 21 studies were screened by full text. The full-text screening was done twice on different days and the inclusion decision was made depending on the population of the study (optometrists, not ophthalmologists), phenomenon, and outcome of interest. Additionally, studies that met the exclusion criteria of timeframe and study design were excluded at this phase. 3 remaining duplicates were excluded in the full-text screening phase.

After screening the studies by full-text, 6 studies were included for evaluation and analysis. The reference lists of the included studies were screened for more studies. From this search strategy, 2 new studies were found and screened first by abstract and then by full text with the same inclusion and exclusion criteria as with the studies found in databases. After the full-text screening, one study was included in the analysis making a total of seven studies for the final analysis. The PRISMA flowchart (Page et al., 2021) of the literature research is found in appendix 1. The details of the studies were gathered into a table that included the authors, publication year and geographical location, study design, population and intervention, and statistical analysis methods. As such, it was easier to compare the differences and the similarities of the study designs. The partial table of the comparison and the summary of the studies is found in table 4.

TABLE 4: Summary of the studies

	Name of the study, authors, year, location	Population, Sample size	Guideline components used	Main objectives	Main results
1	Patterns of adherence to NICE Glaucoma Guidance in two different service delivery models, Chawla et al. 2012, UK	POAG*/NTG*/ PXF*/PDS* patients in two different settings (N = 200)	Seven key standards: GAT*, CCT*, gonioscopy, Disc assessment, VF*, ONH* image, choice of treatment. In monitoring visits: GAT*, ONH* assessment and AC* depth, review intervals, patient's adherence to treatment.	How well NICE guideline was being adhered to in two different settings: a consultant-guided teaching hospital optometry-led shared care setting and a consultant-led district general hospital clinic setting?	Pre-designed assessment sheets in assessing and monitoring glaucoma increase adherence to guidelines in setting 1.
2	Comparison of optometrist glaucoma referrals against published guidelines, Khan et al. 2012, UK	Optometrist referral letters (N = 105)	The number of NCT* readings, repeatable raised IOP*, raised IOP* in isolation, VF* reports, and disc assessment.	How well new glaucoma referrals to the Glaucoma Service of Moorfields Eye Hospital, London followed published guidelines.	Improvement is needed in the use of GAT* and the number of NCT* measurements.
3	The impact of SIGN glaucoma guidelines on false-positive referrals from community optometrists in Central Scotland, Sii et al. 2019, Scotland	Optometrist referrals pre-SIGN (N = 312) and post-SIGN (N = 325)	Number of readings, type of tonometry, Angle assessment, CCT*, disc diameter, R/D* ratio, C/D* ratio, recording of optic disc appearance, image attached, number of VFs* done.	To assess the impact of the SIGN 144 guideline on the quality of referrals from community optometrists measured by first-visit discharge rates and the extent of guideline compliance.	FVDR* fell from 29,2 % to 19,4% after the SIGN guidelines and statistically significant improvement in compliance with most referral recommendations (IOP*,

					Optic disc assessment [not in rim/disc ratio] and repeatable VF* defects)
4	Compliance with Primary Open-angle Glaucoma and Primary Open-angle Glaucoma suspect Preferred Practice Patterns in a Retail-based Eye Clinic, Stanley et al. 2018, US	POAG* or POAGS* patients (N = 360)	15 elements: five related to history taking, nine to ocular examination (VA*, pupil examination, anterior slit-lamp examination, IOP*, gonioscopy, ONH*, RNFL* with imaging, DFE*, CCT*, VF) and setting a target IOP*	Determine the level of adherence to the preferred practice patterns guidelines for quality POAG* and POAGS* care among optometrists practising in retail-based eye clinics while participating in a telemedicine pilot project.	Excellent adherence (>98%) to 10 of the 15 PPP* elements. High frequency in DFE*, CCT*, and VF*. Gonioscopy in 47,5%, target IOP* selected only in 15,6% of cases.
5	Therapeutic endorsement enhances compliance with national glaucoma guidelines in Australian and New Zealand optometrists, Zangerl et al. 2015	Optometrists in Australia (N = 574) and New Zealand (N = 244)	patient history, VA*, slit-lamp examination, ONH* evaluation, VF*, gonioscopy, tonometry, RNFL* imaging, CCT*	To assess the prospective adherence to glaucoma guidelines dependent on the clinician's background	Examination techniques complied well with guidelines with possible exceptions of gonioscopy and pachymetry. Targeted training and knowledge of the guidelines enhanced compliance.

6	A comparative study of glaucoma referrals in Souhteast Scotland: effect of the new general ophthalmic service contract, Eyecare integration pilot programme and NICE guidelines, El-Assal et al. 2015, Scotland	Glaucoma referrals from June 2000 – May 2006 (N = 835) and from January 2007 – December 2012 (N = 787)	Glaucoma symptoms, family history, IOP*, optic disc appearance, optic disc image, VF*.	To evaluate the accuracy and outcome of community optometry referrals before and after the implementation of the new general ophthalmic service contract in 2006, the Eyecare Integration Programme pilot in 2008, and the effect of NICE guidelines in glaucoma in 2009	Patients were referred earlier and with fewer false positive referrals after the introduction of the GOS and EIP pilot.
7	Analysis of a Physician-led, Team-based Care Model for the Treatment of Glaucoma, Winkler et al. 2017, US	Patient records from 3 years before and after Preferred Practice Pattern implementation. (N = 591)	9 elements: VA*, IOP*, target IOP*, CCT*, C/D* ratio, gonioscopy, fundus photos, OCT*, VF*	To determine the effect of a protocol for a new team-based glaucoma care model to increase conformance with the AAO Preferred Practise Pattern guidelines for the treatment of POAG*	Physician-led, team-based care model increased the compliance with AAO guidelines

*Abbreviations: NTG = normotensive glaucoma, PXF = Pseudoexfoliation glaucoma, PDS = Pigment dispersion syndrome, GAT = Goldman applanation tonometry, CCT = Central corneal thickness, VF = Visual field, ONH = Optic nerve head, AC = Anterior chamber, NCT = Non-contact tonometer, IOP = Intra-ocular pressure, R/D ratio = Rim/disc ratio, C/D ratio = cup/disc ratio, FVDR = first visit discharge rate, POAGS = Primary open-angle glaucoma suspect, PPP = preferred practice pattern, DFE = dilated fundus examination, VA = vision acuity, RNFL = retinal nerve fiber layer

4.3 Data evaluation

The third phase of the integrative review process is to evaluate studies that have been found through the literature review. The evaluation aims to ensure that only rigorous research is included in the review. Because integrative review combines different kinds of research designs, each design needs its own appraisal process. (Whittemore, 2007.) The evaluation process of qualitative studies is controversial. Whittemore (2007) states that the appraisal of the primary sources increases the credibility and quality of the conclusions of the integrative review. On the other hand, Evans (2007) adds that if an integrative review's focus isn't primarily on the study findings but on determining the scope and nature of existing research, then the quality of the studies is not a critical issue.

In this thesis, the primary sources were retrospective studies that were published in academic journals.

4.4 Data collection and analysis

After a comprehensive literature search, the data from studies was collected into an Excel table as Whittemore (2007) suggests. As such, the data from different sources is in a compact form, and variables of interest, relationships, or issues are easy to compare. The data collection form also helps the researcher to examine the type of data that will be extracted from the studies (Evans, 2007). In the table form, the data was abstracted and arranged into subgroups and under different umbrella terms so that the common themes were easier to identify and compare. Umbrella terms were examination and adherence. The first one included all the results that explained the guideline adherence during the eye examination process and the latter explained factors affecting the guideline adherence. Subgroups were accuracy in referrals, IOP, visual fields, optic disc, imaging, things affecting adherence, compliance to guidelines, VA, gonioscopy, CCT, and anterior chamber. The collected data was in an Excel table, where it was easy to filter by umbrella terms or subgroups to create different displays from different subgroups. An example of the data collection is in table 5.

Table 5: An example of the data collection: subgroup IOP

Study	Quotation	Summary	Conclusion	Sub-group	Umbrella term
6	The referring optometrist documented the IOP in 618 patients (74 %) in group A and in 597 referrals (75.9 %) in group B	IOP: 74% in group A, 75,9% in group B	IOP measurements only from 75%	IOP	Examination
3	IOP reading taken on one occasion only pre-SIGN 61,5%, post-sign 45,3%	Single IOP measurement decreased from 61,5% to 45,3 %	Fewer single-IOP measurements	IOP	Examination
3	Type of tonometry: Contact tonometry pre-SIGN 58,8%, post-SIGN 79,6%	Use of contact tonometry increased from 58,8% to 79,6 %	Increase in using contact tonometry	IOP	Examination
2	NCT was reported as the instrument used in 69 (66%) letters, contact applanation (Goldmann or Perkins) tonometry in 3 (3%) letters, with the remainder of letters not specifying the device used	NCT in 66 % of the letters	NCT mostly used tonometry	IOP	Examination

For the data analysis, only results that had statistical significance were included. The data in the studies was in statistical form and the statistical analysis would have been possible to make in some of the cases. This was not chosen, because the study questions and aims of the thesis conducted the study to a more comprehensive view rather than to a statistical generalization. The interest of the analysis was more in understanding the changes in optometrists' working after the

guideline publication rather than generalization. For this reason, also the observations in the discussion part of the studies were included in the data collection phase and further in the analysis.

As Whittemore (2007) suggests, the collected data was analysed using narrative analysis data, although it has its limitations regarding rigorous data management and has been criticised because of its subjective nature (Evans, 2007). Because the data was collected in table form and classified under different subgroups, the synthesis could be made one category or group in turn. Differences and common divisors were searched and integrated. Explanations for the results were considered and interpretation for conflicting evidence was made. As recommended by Whittemore & Knafl (2005), conclusions were verified with the primary data to ensure accuracy and finally, a synthesis of the different subgroups was made.

5 RESULTS

5.1 Guideline adherence in the comprehensive eye examination

In comprehensive eye examination, the adherence to **vision acuity measurement** was excellent (Stanley et al., 2018; Winkler et al., 2017; Zangerl et al., 2015). Also, **a slit-lamp examination of the anterior segment** was performed on all patients (Stanley et al., 2018; Zangerl et al., 2015). Despite that, performing **gonioscopy** showed poor adherence in the studies. In the study by Winkler et al. (2017), only about 8 % of community optometrists performed gonioscopy. The SIGN guideline increased the angle assessment done by either Van Herick's method or by gonioscopy from 14,4 % to 32,9 % (Sii et al., 2019), but it remained lower than in the study by Stanley et al. (2018), where 47,5 % of optometrists working in retail-based clinics performed gonioscopy. In New Zealand, up to 55,6 % of optometrists performed gonioscopy, but it was still the limiting technique in the examination. Also, the respondents in the latter study were more likely to have therapeutic endorsement than the national averages, which increases the use of more sophisticated techniques. (Zangerl et al., 2015.) Exception to low adherence was found in the study by Chawla et al. (2012) where 96 % of hospital optometrists performed gonioscopy and in the study by Winkler et al. (2017) where team-based model intervention increased the adherence to gonioscopy from 66,7 % to 93,3 %. This was explained by gonioscopy training that optometrists working in a hospital have had but community-based optometrists haven't (Chawla et al. 2012). The poor adherence to gonioscopy leads to missing suspicious angles requiring peripheral iridotomies which was seen in the study by Khan et al. (2012) where 12 patients referred to the hospital had narrow angles but only 4 of them were referred based on suspicious angles.

Adherence with **IOP measurements** varied between studies from three quarters (El-Assal et al., 2015) to 100% or almost (Chawla et al., 2012; Khan et al., 2012; Sii et al., 2019; Stanley et al., 2018; Winkler et al., 2017; Zangerl et al., 2015). The effect of the guidelines on optometrists' practice was seen in the number of IOP readings measured and in the used tonometry. After the guideline implementation, single IOP measurements and the use of NCT decreased while repeated IOP measurements and the use of applanation tonometry increased (Sii et al., 2019; Zangerl et al., 2015) except in one study, where NCT was the most used tonometry in 66 % of the referral letters (Khan et al., 2012) even after the guideline introduction. This was explained partly by the "pre-

screening" part of the eye examination that is made by non-optometric staff, but Khan et al. (2012) and El-Assal et al. (2015) encourage optometrists to use GAT for IOP measuring for it is recommended in the guidelines and ensure that the optometrists' have the needed equipment and skills to perform GAT. When NCT was used, IOP was measured three times in 61 % of the referral letters and 67 % if the patient had raised IOP without other signs of glaucoma (Khan et al., 2012). Measure of the central corneal thickness increased from 2,9 % to 50 % after the SIGN guidelines (Sii et al., 2019). **CCT** was measured in about half of the patients in district general hospital setting while in optometry-led shared care setting it was measured in 96 % of the patients (Chawla et al., 2012). In retail-based eye clinics, CCT was measured from 88,6 % of the patients (Stanley et al., 2018). Zangerl et al. (2015) included CCT as a part of a complete examination of a glaucoma suspect patient. In their study, only 12-13 % of Australia's and New Zealand's optometrists performed all recommended tests.

The adherence to performing **visual fields** to glaucoma suspect patients was at a good level. Visual fields were evaluated from 71 % to 100 % of the patients (Chawla et al., 2012; El-Assal et al., 2015; Khan et al., 2012; Sii et al., 2019; Stanley et al., 2018; Zangerl et al., 2015). In the study by Sii et al. (2019), the guideline implementation increased the number of repeated visual fields tested while in the study by El-Assal et al. (2015), the amount of visual field testing stayed the same after guideline implementation. Also, the amount of normal or abnormal visual fields found by the optometrist didn't change after the implementation (El-Assal et al., 2015). Khan et al. (2012) explain the lowest adherence and reliability of visual fields with the limited time that general community optometrists have with the patients and El-Assal et al (2015) add the limitations regarding the equipment and patient compliance that decrease the number of visual fields performed in the community optometrist's practice in comparison to the hospital environment.

Excellent adherence (99 %–100 %) was also shown when **assessing the optic nerve head** (Chawla et al., 2012; Khan et al., 2012; Stanley et al., 2018; Zangerl et al., 2015). Differences were found in the used technique or whether the pupils were dilated or not. Binocular ophthalmoscopy was rarely the only examination used when assessing the ONH. For a stereoscopic view, funduscopy or stereoscopic imaging was used by a large portion of optometrists. (Zangerl et al., 2015.) Pupil dilation when assessing the optic nerve head was done from 91,1 % (Stanley et al., 2018) to 50 % in Australia and 39 % in New Zealand (Zangerl et al., 2015). The impact of the published guidelines was seen in the study by El-Assal et al. (2015), where the optic disc documentation in the referral letters increased from 85,4 % to 93 % after guideline publication. Even

bigger change was seen in the study by Sii et al. (2019) where disc diameter assessment increased from 3,8 % to 19,4 % and the assessment of C/D ratio increased from 58,7 % to 83,6 %. In follow-up visits, optometry-led shared care setting performed disc assessment in 100 % of the patients while district general hospital setting performed it only in 90 % of the patients (Chawla et al., 2012).

Variation occurred with adherence to **optic nerve head imaging.** While in the study by Chawla et al. (2012), disc imaging was the worst performing indicator (74 % in setting 1 and 10 % in setting 2), it was performed to 99,4 % of the patients in Stanley et al.'s (2018) study. Zangerl et al. (2015) found 71 % and 84 % of optometrists in Australia and New Zealand performing optic nerve head imaging. Almost a third of them included visualization of RNFL to the evaluation of ONH. Although OCT was used at least in 75 % of the imaging and over 60 % in a new patient assessment, only 15–26 % combined it with other tests that are required when assessing a glaucoma suspect patient. (Zangerl et al., 2015). The presentation of clinical guidelines increased the amount of optic nerve head imaging. After SIGN guidelines, the number of referrals with optic disc image attached increased from 7,7 % to 36,8 % (Sii et al., 2019). Also, Winkler et al. (2017) found an increase in OCT photos from 48,1 % to 68 % and in fundus photos from 44,4, % to 73,3 % after implementation of new guidelines and team-based model. The increase was also visible among the optometrist group, where the amount of fundus photos was 24,5 % before guidelines and 64,2 % after, but not among community optometrists, where fundus photos were included in 1,6 % of the patients (Winkler et al., 2017). El-Assal et al. (2015) emphasize the importance of the attached ONH photos in referrals as they improve the quality of the referral and aren't dependent on the clinical skills of the optometrists. If photographs are attached to the referral, they give more information than the verbal assessment of the ONH. In contrast, taking and attaching optic disc images decreased the commenting of the optic disc in referrals which may lead to impaired clinical skill of the optic disc assessment. (El-Assal et al., 2015.)

Among examination processes, guidelines affected **optometrists' referrals** which were made earlier and with fewer symptoms than before guideline implementation. Before clinical guidelines, loss of one line of Snellen's visual acuity occurred in 12 patients and afterwards, only 3 patients had a loss in VA. In addition, the number of patients with glaucoma symptoms fell from 70,2 % to 54 % and the average IOP in referrals dropped from 23,4 mmHg to 21,4 mmHg after the guidelines. (El-Assal et al., 2015.) The referrals were also more accurate which decreased the first visit discharge from the hospital from 29,2 % to 19,4 %. (Sii et al., 2019). In contrast, Khan et al. (2012) point out

that there is still a need for better adherence to referral instructions among optometrists when referring patients to the hospital. This concerns mostly the use of applanation tonometry, recommended four IOP readings and referring by raised IOP in isolation. In Khan et al.'s (2012) study, raised IOP was the most common reason for referral (73 % of the cases), and from those referrals, 43 % had no other abnormalities found in the eye examination. Sii et al. (2019) add the lack of repeatable vision field defects and the absence of CCT or angle grading in the referrals to the list of reasons for non-compliance seen in the referral letters.

Glaucoma guidelines increased the **accuracy of the diagnosis** made by optometrists. After the guideline implementation, the glaucoma suspect referrals that were found to be normal eyes fell from 37,6 % to 24,1 %. In addition, the number of glaucoma suspects and open-angle glaucoma patients was significantly bigger while other eye conditions than glaucoma were found significantly less. (El-Assal et al., 2015.) Also, Sii et al. (2019) found that the number of normal eyes in referrals fell from 27,3 % to 18,5 % after the SIGN implementation and in contrast, the number of glaucoma suspects rose from 30,3 % to 32,5 %, and angle closures from 8 % to 11,5 %.

In conclusion, the adherence to guidelines in comprehensive eye examination was at a good level. Basic examination with patient history, VA, slit-lamp examination of the anterior chamber, IOP, and ONH assessment was done with excellent adherence to almost all the patients. Gonioscopy, visual fields, and CCT measurement were the most infrequently done tests, although they were done more often to patients with multiple visits or diagnosed POAG. (Stanley et al., 2018; Zangerl et al., 2015.) Also, the hospital-shared care setting with trained optometrists had better adherence compared to non-specialist glaucoma care provided by ophthalmologists (Chawla et al., 2012).

5.2 Factors affecting guideline adherence

Different aspects affecting guideline adherence were found. When comparing community optometrists to a hospital setting, one factor affecting adherence is whether the needed **equipment** is available or used (El-Assal et al., 2015, Chawla et al., 2012). Other factors include knowledge and education, team care models, and pre-designed assessment sheets.

Sii et al. (2019) state that **the education and feedback** to community optometrists increase their compliance with guidelines. This can be seen in Chawla et al.'s (2012) study where only 8 % of

community optometrists performed gonioscopy in comparison to 96 % of hospital-based optometrists. The latter are fully trained in gonioscopy which explains the difference. Further education and participation in major conferences increased the adherence to guidelines which was seen in the application of better clinical examinations and the assessment of the ONH (Zangerl et al., 2015). Instead of providing additional training to a few optometrists Sii et al. (2019) recommend educational support for all optometrists to improve their diagnostic capabilities and optometry community's skills. Zangerl et al. (2015) agree with this and suggest that clinical training should be included in core training. The education of the whole optometrist community is important because the time since graduation is found to be negatively correlated with the likelihood of performing a high-quality assessment of the ONH. Understanding and upkeeping with new technologies is more likely with continuing education. (Zangerl et al., 2015.)

Additionally, it is stated that also **the up-to-date knowledge of the guidelines and their importance** affect the adherence and the quality of glaucoma care. Optometrists with better knowledge of the guidelines are two to nine times more likely to perform tests included in the guidelines, dilate pupils, and assess the ONH. (Chawla et al., 2012; Stanley et al., 2018; Zangerl et al., 2015.)

Collaborative methods and team care increase adherence to glaucoma guidelines (Stanley et al., 2018; Winkler et al., 2017). In Stanley et al.´s study (2018), retail-based optometrists were participating in a telemedicine project, where their examination results were sent to a fellow-ship-trained glaucoma sub-specialist who offered feedback on diagnosis and management. This project was considered to affect the excellent adherence to glaucoma guidelines found in the study. Winkler et al. (2017) studied the effect of the team care model on adherence to guidelines. In the model, a glaucoma specialist screens, diagnoses, and sets target IOP and treatment plans for POAG patients and an optometrist monitors the patients with stable POAG according to AAO guideline recommendations. The patient visits an ophthalmologist every 3 years even if the disease is stable. Winkler et al. (2017) found that the implementation of the team care model increased adherence significantly. The number of patients that had had VF, gonioscopy, CCT measurement, and imaging either with OCT or fundus photos increased from 35,2 % to 76 % after the implementation of the team care model. Also, the amount of single examination components increased by over 20 %.

Chawla et al. (2012) explain the level of adherence with **the use of pre-designed assessment sheets** that included all expected examinations and acted as a memoir for the optometrists. The

effect of the sheet was visible with new patients in the number of CCT measurements and performed gonioscopy and with follow-up patients in the number of anterior chamber depth assessments. Chawla et al. (2012) highlight the advantage of the sheets for their checklist feature that leads to improved quality in assessment and management and minimises differences in provider practices.

6 IMPLEMENTATION OF THE RESEARCH DEVELOPMENT WORK

The second part of this thesis was a development work whose outcome was a guideline for assessing and managing a patient with primary open-angle glaucoma. The guideline was made after the idea of the Finnish Ethical Board of Optometry (OEN), and it will be delivered to them to utilize and implement. The guideline is supposed to be used by all optometrists in Finland. When developing evidence-based protocols, Polit & Beck (2017) recommend that it is made in teams by reflecting on the accumulated research evidence and peer review to secure clearness and comprehensiveness. This thesis can bring valuable information on both the assessment of the glaucoma and the things that should be considered when creating and implementing the glaucoma guideline in Finland. There is a blueprint for guideline attached to the thesis which is modifiable, and the final guideline will be approved by the Ethical Board of Optometry and the Finnish Association of Ophthalmologists before publication.

The orientation of the development work was in research-assisted development where research supports practical development, and the aspiration is to create generalised information via common learning. The development process can be divided into five phases: justification, organizing, action, evaluation, and distribution. (Toikko & Rantanen, 2009.) This master's thesis covers the first three phases and leaves the last two to OEN to carry out later. The justification for the development work lies in the changing future of the scope of eye health and the increasing need for better knowledge of eye diseases among Finnish optometrists. Organizing of the development work was started in the spring 2023 when a permit for the workshop was asked and a concrete action phase was planned.

The development project aimed to gather participants' ideas and thoughts about the guideline and utilize them when creating the blueprint of the guideline for OEN. For this reason, development action that takes participation into account was chosen. Action that includes participation aims for divergent dialogue where people learn from each other's thoughts. At the same time, human-centred and user-centred designs for the development action were wanted because they consider the viewpoints of the end users. (Toikko & Rantanen, 2009.) Different development tools were browsed in Innokylä and the Snowball Method was chosen (Innokylä, 2023b).

6.1 The Snowball Method workshop

The guideline development was started as a workshop done with six optometrists working in a glaucoma outpatient clinic at Helsinki University Hospital. All participants had several years of experience also from working in an optician store as an optometrist. The workshop was performed using the snowball method which is a cumulative development method. It is mostly used in the field of teaching and learning but was selected to use here because it produces new thoughts and perspectives that are necessary to diminish the subjectivity of the guideline made only by one author. (Innokylä, 2023; Learning Scoop, 2023.)

The workshop was based on different themes that were discussed. Themes were:

1. The content of the guideline for optometrists about assessing and managing a patient with POAG
2. The structure of the guideline
3. The implementation and distribution of the guideline

The workshop was held on 10th August 2023 in a meeting room where three large papers were in different corners of the room. Each paper indicated one theme that was written in the middle of the paper as well as a few inspiring questions. First, the subject of the workshop was introduced, and the idea of the workshop was explained to participants. After that, participants were asked to circle between the papers in pairs and write their thoughts about the themes on post-it notes that were then attached to the paper. Commenting on each other's thoughts was encouraged to create new thoughts. When thoughts were put on paper, the group was gathered together, and all themes were discussed together more specifically. (Learning Scoop, 2023.)

The participants agreed with pre-existing guidelines for their **content.** Their opinion about assessing the anterior chamber was that Van Herrick scaling can be used for screening purposes as it is easy to perform with the equipment existing in an optician store, but for patients with diagnosed glaucoma, gonioscopy should be performed. It was wished that in the guideline not only the high IOP was set as a remarkable factor but also the differences between the eyes should draw the examiner's attention.

The participants were asked about different aspects that may limit the Finnish optometrists performing quality eye examinations guided by the guidelines. **Differences in skills** between opticians

and optometrists were pointed out as well as a **limited amount of time**. Patients' conception of the role and capability of optometrists caused discussion in the workshop. In Finland, optometrists' role is assumed to be only a refraction-maker. In optician chains, supplementary examinations such as OCT or fundus photographs are usually priced separately and as such, optometrists must sell those to a customer. That motivation and discussion about the supplementary tests take their own time from the already limited amount of time spent with the customer. As a result, the workshop participants brought up simpler yet effective tests such as confrontation fields and assessing the papilla with a 90D lens even through an un-dilated pupil.

The guideline was wished to be **simple and compact** so that it could be hung on the examination room's wall. Clarifying pictures, yes/no -boxes or scaling tools were mentioned as factors that help optometrists evaluate the findings. Finnish was preferred for the language of the guideline. When asked, whether the guideline should also be used as a referral tool, the participants did not support the thought. Although an electrical form that includes all the components of the guideline and could be printed out to ophthalmologists was thought to be easier to read, it requires writing the same finding to two different places: to the guideline table and the patient chart. A tool that could be used online or saved as an icon on the computer's desktop got positive support.

With every theme, the guideline was hoped to be **user-friendly**. That was also seen as a factor that would help its implementation and **increase the commitment** of the optometrists to the guideline. By combining a glaucoma guideline with already existing comprehensive eye examination guideline, all the needed examinations would be made with every patient. At the same time, the **education of optometrists** is essential and employers' support for that was wished for as further education was found to be expensive for employees to pay.

Mentioned **agents to implement and distribute the new guideline** were Näe ry, the Finnish Optometrists' Association (SOA), and the Universities of Applied Sciences that teach optometry. Way to do that was through national conferences, social media, visiting optical chains and stores, and teaching guidelines to new optometrists. Motivation of the optician stores and chains was the key aspect because for doing examinations with higher quality, optometrists need more time and support from the employer. Also, **feedback from the ophthalmologist** was thought to be one aspect that motivates and leads to better performance and adherence among Finnish opticians.

6.2 The guideline for optometrists when assessing and referring a patient with POAG

The outcome of the workshop was to develop a guideline for optometrists on assessing and referring a patient with primary open-angle glaucoma. The guideline is based on the four guidelines from the optometry field that are introduced and discussed in chapter 2.3, the current guideline on comprehensive eye examination made by OEN, and the results of the integrative literature review and the workshop discussed above. The guideline is in appendix 3.

The guideline attached is a blueprint and a recommendation for The Ethical Board of Optometry to use as such or to moderate according to their wishes and visual preferences.

7 DISCUSSION

In this thesis, the results of the integrative review showed a poor adherence to performing gonioscopy: only 8–55 % documented the results exception being optometrists working in a hospital environment with glaucoma specialists. Relatively low numbers in performing gonioscopy align with previous studies made among ophthalmologists where half of the ophthalmologists performed gonioscopy (Hertzog et al., 1996; Quigley et al., 2007). This thesis showed that optometrists were still less committed to gonioscopy than ophthalmologists. Performing gonioscopy is included in the curricula of the Finnish optometry studies (Metropolia, 2023; Oulun ammattikorkeakoulu, 2023) but no studies about how frequently it was performed in Finland were found. The Ethical Board of Optometry has surveyed how Finnish optometrists perform different clinical procedures and they found that 12 % of optometrists examined the anterior chamber depth from every patient, 48,5 % if needed and 39,5 % never. Of the latter, 57,7 % said that they don't know how to do it and 28,5 % can't interpret what they see. The rest of the respondents didn't find the examination relevant (9,2 %) or didn't have the needed equipment (4,6 %). (Optometrian Eettinen Neuvosto, 2019.) The survey report didn't specify whether the used method was gonioscopy or Van Herick's. The result confirms the need for training and continuing education among Finnish optometrists which was also one key aspect in increasing the adherence to guidelines according to both the integrative review and the development workshop of this thesis.

Among gonioscopy, performing ophthalmoscopy is found to be an alarming weakness among Finnish optometrists: up to 60 % of optometrists never use ophthalmoscopes (Optometrian Eettinen Neuvosto, 2019). This result isn't parallel to the results in the integrative literature research of this thesis, but it was recognized among the participants of the workshops where the use of fundus photos as a substitute for performing ophthalmoscopy was discussed. As El-Assal et al. (2015) write, a picture tells a lot more than just words, but pictures can't replace the use of an ophthalmoscope because then there is a chance that the clinical skills in assessing the optic disc may be impaired. The binocular, stereoscopic view of the optic disc should be the recommended examination in the Finnish glaucoma guideline for optometrists, and imaging should only be a supplemental test and visual information attached to the possible referral letter or be used in follow-up visits. In the survey by the Ethical Board of Optometry, 86 % of the optometrists measured IOP by routine, 13,5 % if needed and 0,5 % never (Optometrian Eettinen Neuvosto, 2019). In the integrative liter-

ature research of this thesis, the glaucoma guidelines had a positive effect on the IOP measurements and the used tonometry. It is possible that in the future if glaucoma guideline is presented in Finland, the number of IOP readings will increase.

In the workshop of this thesis, it was pointed out that it is important to not only pay attention to patients with IOP over 21 mmHg but also to other signs of suspected glaucoma. In addition, the threshold values for referrals should be discussed and decided together with optometrists and ophthalmologists before guideline implementation, because the threshold value of over 21 mmHg is recognized to burden the eye health care in previous studies. According to Founti et al. (2018), the IOP >21 mmHg in isolation is the most common reason for referrals but at the same time, it doesn't predict glaucoma well: the positive predictive value is found to be 56 %. To increase it, it has been suggested that the threshold value of the IOP in isolation referrals could be >26 mmHg. In addition, when combining high IOP with other signs of glaucoma such as changes in the optic disc, consistent glaucomatous visual field defect, narrow anterior angle, or other glaucoma-associated conditions, the positive predictive value increased to at least 89 %. (Founti et al., 2018.)

The purpose of guidelines is to increase the quality of the clinical examinations and possible referrals from optometrists to ophthalmologists not to burden the ophthalmologists by increasing the number of patients referred to them. According to the integrative review of this thesis, the newer guidelines and their referral refinements increased the accuracy of the diagnosis made by optometrists and decreased the first-visit discharge in the hospital. In 2011, Shah and Murdoch studied the impact on referrals in 2009 after the NICE guideline for diagnosis and management of chronic open-angle glaucoma was published and the Association of Optometrists, Association of British Dispensing Opticians, and Federation of Ophthalmic and Dispensing Opticians recommended referring a patient with an IOP over 21 mmHg to an ophthalmologist. According to their study, the number of referrals increased markedly while the positive predictive value fell which tells about a large number of false positives and an increase in patients in hospital eye service (HES). (Shah & Murdoch, 2011.) After that, different referral refinements are made to decrease the number of referrals to HES with evidence of effectiveness (Harper et al., 2020; Ratnarajan et al., 2013).

When new guidelines and examinations are presented, continuous education must be kept in mind and offered when needed. According the literature review of this thesis, knowledge of both the guidelines and the diseases will increase the adherence to following guidelines which will lead to earlier detections of eye diseases and more accurate referrals (El-Assal et al., 2015; Sii et al.,

2019). Already in Finland, optometrists – who have advanced studies on eye diseases and different examinations compared to opticians – are more aware of the changes in the optic nerve head in glaucoma (Optometrian Eettinen Neuvosto, 2019).

According to the workshop, the lack of both patients' and optometrists' knowledge of the disease was one of the burdens that limit the quality of eye examinations. This development research showed that education was one of the main factors to increase the guideline adherence of optometrists which led to higher quality examinations and earlier and more accurate detections of glaucoma. I state that not only the guideline but also better clinical decision-making and quality in the eye examinations and interpretations are essential when assessing patients with suspected glaucoma. With better knowledge about the disease, optometrists can better evaluate the results of their examinations and make more precise clinical interpretations to avoid false positive referrals. Thus the attention in education should be on interpretation of the results rather than performing all the needed tests and examinations.

In conclusion, new approaches to patient care are needed as the population ages and the need for eye health providers increases. In Finland, the law regulations limit the permissions of optometrists when it comes to the management of eye diseases. Despite that, the education of optometrists has become more clinical and includes the detection of eye diseases. This education enables more difficult examination procedures and more detected eye diseases by optometrists. I assume that the ophthalmologists will benefit from focusing their work on those who most need their care and that the optometrists can be valuable team members in the collaborative care of the POAG patients. To perform high-quality eye examinations and refer patients with adequate referral letters, clinical guidelines are needed for the optometrists to use. This thesis and its results can be used as a starting point for this kind of guideline development in Finland.

7.1 Trustworthiness of the research development work

During the integrative review process, the risk of bias and error exists in every phase of the process (Whittemore, 2007) and to avoid that the protocol of integrative review introduced by Evans (2007) was followed precisely. Structured steps and systematic summary of the results reduce errors that may originate from the author's pre-existing knowledge as can be seen in traditional literature reviews (Munn et al., 2018). This study was made by only one actor which caused limitations to the

research work that were considered in every phase. During the literature research phase, help from a librarian was used to gain comprehensiveness and to improve the specificity of the search. Also, different search strategies were used so that all studies within the scope of interest could have been found. (Whittemore, 2007.)

Screening of the studies was made twice on different days to ensure that inclusion and exclusion criteria were met, and no subjective priori views affected the screening process. With some studies, inclusion was more difficult than with others and the help and discussion with another author could have been useful. In these cases, notes were made on different days and the final inclusion decision was made after screening the study several times. The final decision was made based on the study question and the aims of the master thesis because these are the key aspects that guide the study process (Munn et al., 2018).

Although Evans (2007) and Whittemore (2007) suggest that two reviewers do the data collection to minimize the transcription error, in this thesis only one coder was used. The possibility of an error was kept in mind and the work was done as rigorously as possible copying sentences and numbers straight from the articles instead of handwriting them. Data collection was made in table form and quotes from the original studies were copied from articles rather than written by a collector. Summaries and conclusions of the straight quotes were evaluated many times to avoid quick or false conclusions.

Studies that could've been critically appraised with appraisal tools, such as RCTs, meta-analysis, or systematic review were not included among the founded studies. After consideration and consulting the advisers, the systematic appraisal was left out from this review. This decision was based on Evans's (2007) thoughts, that the quality of the studies is not a critical issue if an integrative review's focus isn't primarily on the study findings but on determining the scope and nature of existing research. The possible risk of bias in the primary studies was still considered and noticed in the analysis.

During the narrative analysis, special attention was paid to priori views that the researcher might have had about the themes of adherence (Whittemore, 2007). There is still a possibility of subjectivity that originates from having one author in the study.

The development of the glaucoma guideline is based on the integrative review, the existing guidelines, and the workshop. This is presumed to increase the reliability of the guideline as it considers different aspects of the guideline, not only the components of it. During the workshop, the results of the integrative research regarding the aspects that affect adherence were not mentioned to participants. This was done to avoid the presumptions or leading of the participants so that they could come up with their own thoughts about guideline implementation or form. Combining the thoughts made in the workshop with the author's thoughts and later with the thesis order's thoughts brings more valuable information to the guideline and its use and implementation.

The studies analyzed in the integrative research were located in the UK, US Australia, and New Zealand. The scope of optometry and the skills and responsibilities vary between these countries and differ for the ones in Finland. For this reason, the results of the integrative analysis can't be applied directly to Finnish optometrists but the results talk about the situation in countries where glaucoma guidelines exist and are being used. Thus, the results can be used as a possible situation that can exist in Finland and can be considered when the guideline is being created or implemented.

7.2 Ethicality of the research development work

The Finnish code of conduct for research integrity was followed throughout the thesis process (Finnish National Board on Research Integrity TENK, 2023). Reliability and transparency during the integrative research and its data collection and analysis were ensured by writing the different steps in the thesis for readers to follow. The risk of bias caused by subjectivity was noticed and avoided as best as possible. For this thesis, ethical review was not required as no human participants were included in the study. In the thesis report, referring was made in an appropriate manner avoiding plagiarism.

The ethical aspects were considered during the workshop. Before arranging the workshop, permission to use the meeting room and the work time of the participating optometrists was asked from the manager of the outpatient clinic. The invitation to optometrists was sent beforehand and the purpose of the workshop was explained. The participation was voluntary and the thoughts that arose during the workshop were analysed anonymously.

7.3 Evaluation of the research development work

The result of this thesis is the guideline for optometrists for assessing and managing a patient with primary open-angle glaucoma. Its blueprint is attached to the thesis and delivered to the Finnish Ethical Board of Optometry (OEN). The guideline considers all the aspects aroused from the different stages of the thesis project: the contents and the usability. The guideline consists of all the recommended tests for evaluation of the POAG suspect patient and explains why the recommended tests are done. It is compact and fills one A4 size paper so that it is easy to follow and use as a memoir. It includes pictures for clarification. The threshold values for further referral are equal to current Finnish recommendations.

The OEN decides how and when the implementation of the guideline is carried out. Clinical guidelines are made to be used and to support professionals' work. For this reason, it is important to concentrate on the dissemination and promotion of the guidelines, which are the most common barriers to the implementation of the guidelines. Other factors to reduce the adherence to guidelines are lack of transparency regarding the applicability or supporting evidence, lack of agreement to recommendations, organisational constraints, and unclear guideline recommendations. Nguyen et al. (2021) suggest online practice guidelines and social media, email reminders, and incentives to read the guidelines as a tool for dissemination. Also, educational opportunities such as training, conferences, or workshops could increase the success of the guideline implementation. Studies have shown that dissemination and implementation of the guidelines are more successful if multiple approaches are used. (Nguyen et al., 2021.) The evaluation of the guideline's implementation or effectivity is not discussed in this thesis but it is recommended for further research.

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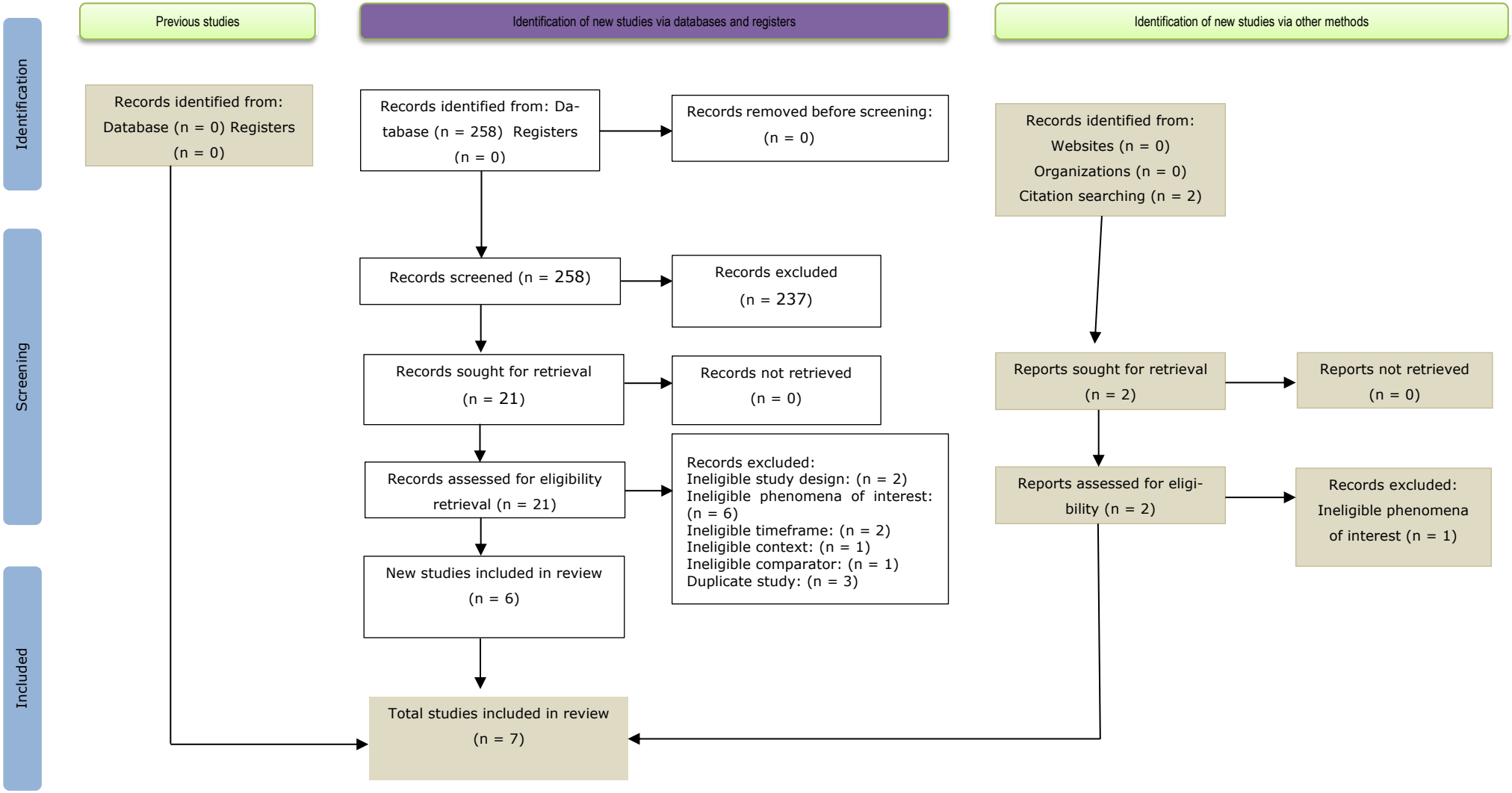
APPENDIX 1: Prisma flow-chart (JBI Sumari)



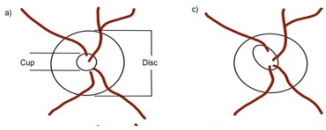
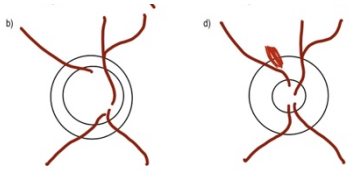
APPENDIX 2: Comparison of the main contents of the guidelines

	Guidelines			
	NÄE RY	AOA	Optometry Australia	The College of optometrists
Patient history and risk factors	Yes	Yes	Yes	Yes
Visual acuity	Yes	Yes	Yes	No
Pupil assessment	Yes	Yes	Yes	No
IOP	Yes: applanation or rebound tonometry	Yes: applanation tonometry, diurnal variability, symmetry	Yes: applanation tonometry, diurnal variation	Yes: applanation tonometry, diurnal variation
Eyelids, tear film	Yes	No	No	No
Central corneal thickness	Yes	Yes	Yes: pachymetry or anterior OCT	No
Endothelial pigmentation	Yes	No	Yes	No
Anterior chamber depth	Yes: Van Herick	No	No	Yes: Van Herick
Anterior chamber angle	No	Yes: Gonioscopy	Yes: Gonioscopy	Yes: Gonioscopy
Iris	Yes	No	Yes	No
Lens	Yes	No	Yes	No
Vitreous	Yes	No	No	No
ONH assessment		Yes: stereoscopic evaluation through a dilated pupil		
- symmetry	Yes		Yes	No
- C/D ratio	Yes		Yes	Yes
- hemorrhages	Yes		Yes	Yes
- neuroretinal rim	Yes		Yes	Yes
Macular area	Yes			

Retinal vessels	Yes			
NFL assessment	Yes: OCT	Yes: red-free filter	Yes: red-free filter	No?
Peripapillary atrophy	No	Yes	Yes	No
Fundus	Yes			
Digital imaging	Yes: for documentation	Yes: for documentation	Yes: when available	Yes
Visual fields	Yes	Yes: SAP preferred	Yes: SAP preferred	Yes: SAP preferred

APPENDIX 3: Guideline

Glaukoomaepäillyn potilaan tutkiminen

	Miksi?	**Huomioita**
Anamnesis: riskitekijät Kohonnut silmänpaine, ikä, afrikkalainen etninen tausta, lähisuvussa glaukoomaa, myopia	Jos 1 tai useampi riskitekijä tulee ilmi -> huomio glaukoomariski tutkimuksissa	
Pupillireaktiot	Muiden näköhermoon vaikuttavien sairauksien poissulku	
Visus	Muiden näköhermoon vaikuttavien sairauksien poissulku	Glaukooma ei heikennä näköä ennen kuin tauti on edennyt pitkälle
Silmänpaine: applanaatiotonometri ja useampi mittauskerta eri vuorokaudenaikoina	Korkea silmänpaine riskitekijä: normaali ei sulje pois glaukoomaa. Tutki muutokset näköhermonpäässä!	Jos 21-24 mmHg -> uusintamittaus. Jos silmien välinen ero >4 mmHg -> epäily ja lisätutkimukset
Sarveiskalvon paksuus	Vaikutus silmänpainelukemiin: huomioi laserleikatut ja silmien väliset erot	Pakymetri tai etuosa-OCT
Etuosien mikroskopointi		
SAK:n endoteelin pigmentaatio	Sekundääriglaukoomien poissulku	
Mykiö: exfoliaatio	Sekundääriglaukoomien poissulku	
etukammion syvyys		Van Herick
kammiokulman avoimuus	Sekundääriglaukoomien poissulku	Gonioskopia
Näköhermonpään arviointi 		Stereoskooppinen näkymä ensisijaisesti laajennetun pupillin kautta
C/D suhde	Kasvaa glaukooman edetessä	Jos >0,5 -> epäily
symmetria		Jos ero >0,2 -> epäily
reunavuodot	Kertoo etenemisestä	Jos on -> epäily
RIMin paksuus		ISNT-sääntö
Kuvantaminen		
Silmänpohjakuvaus	Dokumentaatioksi ja vertailuun	
OCT		Yhteys muihin tuloksiin
Näkökenttätutkimus		Jos ei laitteita: sormiperimetria