Diabetes Eye Care in Norwegian Optometric Practice

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2013

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Series of dissertations submitted to the
Faculty of Medicine, University of Oslo
No. 1487

ISBN 978-82-8264-510-2

Cover: Inger Sandved Anfinsen.
Printed in Norway: AIT Oslo AS.

Produced in co-operation with Akademika publishing.
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To Emma and Hanna

If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you,
But make allowance for their doubting too;
If you can wait and not be tired by waiting,
Or, being lied about, don't deal in lies,
Or, being hated, don't give way to hating,
And yet don't look too good, nor talk too wise;

If you can dream - and not make dreams your master;
If you can think - and not make thoughts your aim;
If you can meet with triumph and disaster
And treat those two imposters just the same;
If you can bear to hear the truth you've spoken
Twisted by knaves to make a trap for fools,
Or watch the things you gave your life to broken,
And stoop and build 'em up with worn-out tools;

If you can make one heap of all your winnings
And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings
And never breath a word about your loss;
If you can force your heart and nerve and sinew
To serve your turn long after they are gone,
And so hold on when there is nothing in you
Except the Will which says to them: "Hold on";

If you can talk with crowds and keep your virtue,
Or walk with kings - nor lose the common touch;
If neither foes nor loving friends can hurt you;
If all men count with you, but none too much;
If you can fill the unforgiving minute
With sixty seconds' worth of distance run -
Yours is the Earth and everything that's in it,
And - which is more - you'll be a Man my son!

If by Rudyard Kipling (1865-1936)

Acknowledgements

The thesis is the result of a long and educational academic journey. The journey would not have been possible without the support of my family; my daughters Emma and Hanna and my mother Kari.

The thesis would not be complete without the persistent and generous guidance of Professor Pål Gulbrandsen and Professor Jørund Straand. Pål, I appreciate your confidence in me. You have challenged me to stretch further and to see my research in different perspectives. Jørund, you have an eye for details and clinical pearls. I am indebted for you both for your extensive support.

To optometrists participating in the study: your contribution was essential!

To my co-authors and co-workers; Jak Jervell, your knowledge about diabetes is immense and I much appreciate your academic and personal support. Leiv Bakketeig, you introduced me to epidemiological research. Ragnheiður Bragadottir, you provided an ophthalmologists point of view in the design of the studies. Carl GP Platou, your knowledge about the GLUP population and involvement in the HUNT study was vital. Erik Wøllo, you helped with the data collection for the population study and have kept me in touch with daily life in optometric practice. Ragnhild Wivestad Jansson and Geir Bertelsen, your work in analysing the retinal images is much appreciated.

To my collaborators; The Norwegian Association of Optometry, you have provided information and practical support and I value the discussions with secretary general, the professional manager and members of the board of the Norwegian Association of

Optometry. The Norwegian Diabetes Association, you have provided me with information, and given me the opportunity to participate in conferences with fellow PhD students and researchers in the field of diabetes, and to develop network with other researchers and institutions. The collaboration with The Nord-Trøndelag Health study (HUNT) was a result of one of these meetings. Kristian Midthjell, I appreciate the interesting discussion over lunch and the possibility to undertake the population study in Verdal.

Finally, I am deeply grateful for the support and encouragement from Buskerud University College and all my colleagues at the Institute of optometry and visual science.

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Preface

The inspiration to commence a study of vision and ocular health in patients with diabetes is founded on my own professional experience. Through work in low vision clinics and hospital eye departments, I have fitted low vision aids to patients with visual impairment due to diabetic retinopathy. In private practice and in low vision clinics I have detected retinopathy as the first sign of diabetes and have made referrals that have resulted in a diagnosis of diabetes.

When I began my journey of research, the Norwegian Directorate of Health had not issued the national professional guidelines for diabetes. The Norwegian Association of Optometrists had no guidelines for clinical practice. The Norwegian Society of General Practitioners' treatment programme for diabetes recommended eye care, but knowledge of the eye care provided in Norway was sparse. This was the fuel to explore and address the role of the optometrist in the eye care of patients with diabetes.

Vibeke Sundling

Kongsberg 2012

List of abbreviations

ACCORD, Action to Control Cardiovascular Risk in Diabetes trial

BCVA, best corrected visual acuity

BSc, Bachelor of Science

CI, Confidence interval

DCCT, Diabetes Control and Complications Trial

DR, diabetic retinopathy

FIELD, Fenofibrate Intervention and Event Lowering in Diabetes study

GP, general practitioner

$HbA_{1c,}$ Hemoglobin A1C (glycated haemoglobin)

HDL, high density lipoprotein

HUNT, Nord-Trøndelag Health Study

HVA, habitual visual acuity

IAPB, International Agency for the Prevention of Blindness

IGT, impaired glucose tolerance

IRMA, intraretinal microvascular abnormalities

KDM, known diabetes

MSc, Master of Science

NDA, Norwegian Diabetes Association

NGT, normal glucose tolerance

NOF, The Norwegian Association of Optometry

NPDR, non-proliferative diabetic retinopathy

OR, odds ratio

PhD, Doctor of Philosophy

POR, prevalence odds ratio

PR, prevalence ratio

REK, Regional Committee for Medical Research Ethics

SD, standard deviation

SDDM, screen-detected diabetes

S-LDL, serum low-density lipoprotein

SPSS, Statistical Package for the Social Sciences

UKPDS, UK Prospective Diabetes Study

VA, visual acuity

VIMOC, Visual Identification and Management of Ophthalmological Conditions.

WCO, World Council of Optometry

WHO, World Health Organization

1. List of Papers

I. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Optometric practice in Norway: a cross-sectional nationwide study**. *Acta Ophthalmologica Scandinavica* 2007, **85**(6):671-676, *doi: 10.1111/j.1600-0420.2007.00929.x.*

II. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Suspected retinopathies in Norwegian optometric practice with emphasis on patients with diabetes: a cross-sectional study**. *BMC Health Services Research* 2008, **8**:38.

III. Sundling V, Gulbrandsen P, Jervell J, Straand J: **Care of vision and ocular health in diabetic members of a national diabetes organization: a cross-sectional study**. *BMC Health Services Research* 2008, **8**:159.

IV. Sundling V, Platou CGP, Jansson RW, Bertelsen G, Wøllo E, Gulbrandsen P: **Retinopathy, visual impairment and eye examination in diabetes, impaired glucose tolerance and normal glucose tolerance – The Nord-Trøndelag Health Study (The HUNT study).** *Acta Ophthalmologica 2012,* **90**(3): 237-243*, doi: 10.1111/j.1755-3768.2010.01998.x*

V. Sundling V, Gulbrandsen P, Straand J: **Sensitivity and specificity of Norwegian optometrists' evaluation of diabetic retinopathy in single-field retinal images.** *(Revised and copy edited manuscript submitted to BMC Health Services Research)*

2. Summary of thesis

2.1 Background

The scope of optometry differs globally, ranging from the dispensing of optical aids to the diagnosis and treatment of certain ocular diseases. In Norway, the profession has developed from craftsmanship into a health profession, regulated by the Health Personnel Act, which was founded on the principles of responsible conduct. The majority of optometrists are employed in private practice and they perform more than one million eye examinations every year. Norwegian optometrists have various academic backgrounds and the content and quality of their eye examinations probably vary, according to their competency level.

About 90 to 120,000 Norwegians have known diabetes, and most of them will develop some degree of diabetic retinopathy during the course of their illness. The reported prevalence of diabetic retinopathy in Norway is 13% to 28%, whereas international population-based studies report a prevalence of 24% to 36%. The reported prevalence of sight-threatening diabetic retinopathy is 1% to - 13%. Diabetic retinopathy is a leading cause of visual impairment in the working age group in Western societies: 5% to13% of blind and partial sight registrations are due to diabetic retinopathy. One percent of patients with diabetes are visually impaired due to diabetic retinopathy; however, as many as 3% to 9% have visual impairment because of concurrent ocular disease.

Diabetic retinopathy can and should be treated before symptoms occur. Most cases of visual loss can be prevented by regular eye examination and early treatment of retinopathy. Screening for diabetic retinopathy is one of the most cost-effective routine interventions for detecting disease. However, establishing a robust screening programme, staffed with trained healthcare professionals, requires considerable organisation and commitment from the individuals involved, as well as appropriate patient education.

Health services research in the field of vision and eye care in Norway is limited. Eye care provided by optometrists is not covered under the National Insurance Act reimbursement scheme, and systematic knowledge of Norwegian optometric practice based on large national studies is lacking. The role of the optometrist in the eye care of patients with diabetes is not clearly defined. The prevalence of diabetic retinopathy is not accurately reported and the prevalence of visual impairment in patients with diabetes is unknown. The national guidelines for diabetes recommend regular eye examinations, but little is known about current eye care practice and compliance with the recommendations.

2.2 Aim

The aim of this thesis is to contribute to health services research on Norwegian optometric practice and the management of vision and ocular health in patients with diabetes. The thesis has four main objectives: (1) to describe Norwegian optometric practice in terms of optometrist and patient characteristics, the routine eye examination, and the collaboration between optometrists and general practitioners and ophthalmologists, (2) to establish the prevalence of visual impairment and suspected retinopathies in patients examined in optometric

practice, to explore the patient-reported prevalence of diabetic retinopathy and visual impairment in patients with diabetes, and to analyse predictors of retinopathy, (3) to evaluate the optometrists' retinal assessment of diabetic retinopathy, and (4) to assess compliance with recommended eye care guidelines and to measure variables associated with regular eye examination, in patients with diabetes.

2.3 Materials and methods

This research had a cross-sectional design. The data were collected between November 2004 and February 2011 using descriptive, clinical, and experimental methods.

Norwegian optometric practice was assessed using a questionnaire, a practice registration form, and an experimental, visual identification and management of ophthalmological conditions (VIMOC) examination (Papers I, II and V). A VIMOC examination tests clinical competency using cases and/or images with accompanying multiple choice questions.

Visual impairment and retinopathy in patients with diabetes were investigated for patients examined in optometric practice using a questionnaire and a practice registration form (Papers I and II), and by clinical examination of a population sample from the Nord-Trøndelag Health Study (HUNT-study) (Paper IV). Associations and predictors of clinical findings of retinopathy and patient-reported retinopathy were analysed for patients examined in optometric practice (Paper II), for patients participating in the clinical examination (Paper IV), and for a sample of members of the Norwegian Diabetes Association (NDA)responding to the questionnaire (Paper III).

Eye care in patients with diabetes was described and analysed for a sample of members of the NDA(Paper III) and a population sample from the HUNT-study using a questionnaire (Paper IV).

Data were analysed by standard uni-, bi- and multivariate statistical methods, by calculation of odds and relative risk ratios, by kappa-analysis, and by calculation of sensitivity and specificity. Information about non-participating optometrists and non-attendees in the population study was collected and analysed.

This research followed the tenets of the Declaration of Helsinki for research involving humans. All studies were submitted to the Regional Committee for Medical Research Ethics (REK). The questionnaire sent to optometrists (Paper I), the practice registration form (Papers I and II), and the VIMOC examination (Paper V) were not subject to specific evaluation and approval. The questionnaires (Papers III and IV) and the clinical examination (Paper IV) were approved by REK.

2.4 Response rates

In all, 508 optometrists (64%) responded to the questionnaire (Papers I and II), of whom 212 (42%) also completed the practice registration form (Papers I and II). In the VIMOC examination, 112 members of The Norwegian Association of

Optometry (NOF) (11%) volunteered to participate, 101 of them (90%) met the inclusion criteria, and 74 (73%) completed the study (Paper V). In total, 1,396 (74%) of the invited members of the NDA responded to the questionnaire and 1,352 of them (97%) were included in the analysis (Paper III). For the sample invited from the HUNT population, 126 (77%) took part in the clinical examination (Paper IV).

2.5 Results

2.5.1. Optometric practice (Papers I, II and V)

Patient history of vision and ocular health was always part of the routine eye examination. The majority of the optometrists also asked questions about general health. In all, 92% of optometrists reported that they undertake ophthalmoscopy as part of their routine examination; direct ophthalmoscopy was most frequently used (Paper I). One in four of the optometrists who completed the practice registration form were qualified to perform dilated fundus examination. Retinal examination was reported for 88% of patient encounters, of which 2% were performed in mydriasis. In patients with diabetes, ophthalmoscopy was performed in 96% of examinations, 2% of which were dilated retinal examinations (Paper II). In all, 4,052 patients were described in the practice registration form study; 72% were 35 years and older, 4% had a known history of diabetes and 12% had known ocular disease. The optometrists reported finding cataracts in 9% of encounters, of which half were found in patients with no previous history of cataract. Clinical findings of retinopathy were reported in 3% of patients; two thirds had no known history of retinopathy. More than 80% of optometrists reported having some form of interaction with general practitioners and/or ophthalmologists. In all, 6% of the patients reported in the practice registration form study were referred. More than half of the cases of retinopathy were considered in need of referral; this occurred more frequently if the patient did not have a known history of retinopathy (57%) than if they did (37%).

2.5.2. Visual impairment (Papers I, II, III and IV)

In all, 2% of the patients encountered in optometric practice were visually impaired (best corrected visual acuity [BCVA] <0.5), of whom half (1% overall) had low vision (BCVA<0.33) (Paper I). For patients with a known history of diabetes, visual impairment and low vision were recorded in 5% and 2% of patient encounters, respectively. Among the NDA members who responded to the questionnaire, 88% reported using some optical correction (Paper III). Fifteen percent reported experiencing visual problems during the previous year and 12% reported visual problems related to their diabetes. In the clinical examination, four participants (3%) had correctable visual impairment, but none were visually impaired (Paper IV); correctable visual impairment was associated with old age.

2.5.3. Diabetic retinopathy (Papers I, II, III and IV)

In the practice registration form study, suspected diabetic retinopathy was found in 10% of patients with known diabetes and 0.2% of patients without an established diabetes history (Paper II). Old age (75 years and older),

hypertension and diabetes were independent predictors of any retinopathy. Diabetes and hypertension were the only independent predictors for vascular retinopathies (Paper II). In the questionnaire, 13% of the NDA members who responded reported a history of diabetic retinopathy, of which more than half of the cases had been laser-treated (Paper III). Disease duration was the only variable where an independent association with history of diabetic retinopathy was found (Paper III). In the clinical examination of the HUNT-sample, diabetic retinopathy was found in 11% of persons with known diabetes and in 4% of persons with screen-detected diabetes (Paper IV). Retinopathy consistent with diabetic retinopathy was in found 3% of persons with impaired glucose tolerance and 10% of people with normal glucose tolerance. Retinopathy was not associated with a known history of diabetes or with current glycaemic status, but previous non-fasting plasma glucose level was an independent risk factor for retinopathy (Paper IV).

2.5.4. Optometrists' assessment of diabetic retinopathy (Papers II and V)

In the practice registration form study, optometrists suspected diabetic retinopathy in 10% of patients with diabetes. However, for patients with a reported history of diabetic retinopathy, half of the cases were not confirmed by the optometrist (Paper II). In the VIMOC examination, the sensitivity (95% confidence interval) for identifying eyes with any diabetic retinopathy was 67% (62% to 72%) (Paper V). The specificity for identifying eyes without diabetic retinopathy was 84% (80% to 89%). Four optometrists (5%) met the standard required for screening programmes for diabetic retinopathy, i.e. at least 80% sensitivity and 95% specificity. Optometrists with a Master of Science in optometry had significantly higher sensitivity than optometrists with a basic optometric education.

2.5.5. Regular eye examination in patients with diabetes (Papers III and IV)

Among the members of the NDA who responded to the questionnaire, 87% had received information about the importance of regular eye examinations and 78% had their eyes examined according to guidelines (Paper III). There was an independent association between regular eye examinations and (1) patients with disease duration greater than 10 years and (2) patients who had received information about eye examinations. In the clinical examination, less than 35% of the HUNT-sample had their vision regularly examined (Paper IV). However, regular examination was associated with a known history of diabetes, and 80% of the participants with known diabetes had regular eye examinations (Paper IV).

2.6 Conclusion

The clinical study showed that eye examination by optometrists detects visual impairment due to refractive error (Paper IV). The practice registration form study demonstrated that optometrists frequently examine patients with diabetes (Papers I and II). Optometrists take medical history, assess ocular health, and contribute to case-finding of ocular disease (Papers I and II). However, both the practice registration form study (Papers I and II) and the experimental study (Paper V) indicated that diagnostic sensitivity for case-finding and assessment of diabetic retinopathy is poor. Further, the results from the practice registration

form study raised some concern, as 25% of the patients with suspected vascular retinopathy and no history of retinopathy or systemic disease were not referred and were only judged to need routine optometric follow-up (Paper II).

The practice registration form study results showed that the prevalence of known ocular disease and visual impairment was higher among those with diabetes than among those without. Surprisingly, the clinical study showed a lower prevalence of diabetic retinopathy compared to previous studies in Norway and other Western countries (Paper IV). This finding was supported by the prevalence of known history of diabetic retinopathy recorded in the practice registration form study (Paper II) and reported by members of the NDA in the questionnaire (Paper III). The lack of an association between diabetic retinopathy and a known history of diabetes/current glycaemic status, despite the predictive value of non-fasting plasma glucose level ten years earlier (Paper IV), indicates how difficult it is to predict diabetic retinopathy, and highlights the importance of regular eye examinations.

The questionnaire surveys of members of the NDA (Paper III) and the HUNT sample (Paper IV) showed that the majority of patients with diabetes have their eyes examined according to guidelines. Compliance with guidelines is associated with both diabetes duration and receipt of information about potential eye complications.

2.7 Inference of results

The optometric practice is an easily accessible place for primary eye care in the Norwegian health care system. The routine optometric examination detects correctable visual impairment and undercorrected refractive error, and encourages case-finding of ocular disease and retinal manifestations of systemic disease. However, the diagnostic sensitivity of the retinal examination appears to be low. Measures should be taken to improve diagnostic sensitivity.

Optometrists do probably take on medical responsibilities, and their clinical decision making and referral habits should be addressed. Consensus on patient management, referral practice and general collaboration with general practitioners and ophthalmologists should be established to ensure the best possible patient care.

Further research is needed in order to estimate accurately the prevalence of diabetic retinopathy and visual impairment among patients with diabetes in Norway.

In patients with diabetes, experience of eye examinations in accordance with national professional guidelines is associated with diabetes duration and receipt of information regarding potential eye complications in diabetes. Most patients with diabetes use some optical correction and the number of patients with diabetes examined in optometric practices is high. Optometric practices have the potential to develop themselves into viable settings for patient education that play an important role in screening for diabetic retinopathy. However, for optometrists to become part of a screening programme for diabetic retinopathy, targeted formal optometric training and mandatory continuing optometric education is necessary.

3. General background

3.1 Introduction

The global prevalence of diabetes is increasing due to an aging world population [1]. Patients with diabetes live longer and more people develop diabetes [2, 3]. The estimated prevalence of known diabetes in the Norwegian general population is 2% [4]. In Western societies, diabetic retinopathy is a leading cause of visual impairment and blindness in the working age group [5]. Ophthalmologic screening of patients with diabetes has been shown to be more cost-effective than many other routine interventions in healthcare [6, 7]. Optometrists are providers of eye care, and patients with diabetes are frequently examined in optometric practice due to refractive errors and presbyopia. Studies have shown that optometrists are able to detect and grade diabetic retinopathy [8]. Furthermore, specially trained optometrists perform well when screening for diabetic retinopathy [9-11]. However, health services research in the field of vision and eye care in Norway is limited.

3.2 Optometry

3.2.1 Definitions

The term optometry is derived from Greek: *optos* (visible) and *metron* (measure). Optometry is defined as "the healthcare profession concerned especially with examining the eye for defects and faults of refraction, with prescribing correctional lenses or eye exercises, with diagnosing diseases of the eye, and with treating such diseases or referring them for treatment" [12]; an optometrist is defined as "a specialist licensed to practice optometry" [13].

3.2.2 Scope of optometry

The scope of optometry differs worldwide [14], and more specifically in Europe [15], ranging from dispensing of optical aids to the diagnosis and treatment of certain ocular diseases. The World Council of Optometry (WCO) is an international optometric organisation representing over 300,000 optometrists from 150 member organisations in 90 countries (including Norway). The WCO defines optometry as follows: "Optometry is a healthcare profession that is autonomous, educated, and regulated (licensed/registered), and optometrists are the primary healthcare practitioners of the eye and visual system who provide comprehensive eye and vision care, which includes refraction and dispensing, detection/diagnosis and management of disease in the eye, and the rehabilitation of conditions of the visual system" [16]. At present, optometry in Norway Includes: (1) the examination of vision and ocular health, and (2) the dispensing and manufacturing of optical correction devices and low vision aids. NOF's vision statement is "…first contact for better vision!" [17].

3.2.3 Regulation of optometry in Norway

In Norway, optometry has developed from a craftsmanship to a health profession, first secured by the Regulation of Optometrists of 22. April 1988 [18]. Furthermore, licensed Norwegian optometrists trained in the use of ocular diagnostic drugs were given diagnostic privilege to use certain ocular diagnostic drugs in 2004 [19] and in January 2009, optometrists were given the opportunity to refer patients directly to an ophthalmologist [20]. Optometry in Norway is regulated by the Health Personnel Act [21], which is founded on the principles of responsible conduct. In 2005, NOF issued competency standards with clinical guidelines [22], and these define the expected standard of Norwegian optometric practice.

3.2.4 Optometric practice in Norway

The majority of optometrists in Norway are employed in private practice, either in independent practices or in national or international companies with multiple practices. Optometrists are also represented in hospital eye departments, low vision clinics, educational institutions and in the optical industry. Norwegian optometrists are a heterogeneous group with regard to academic background. They include practitioners with Technical College, University College degrees (2 to 3 years course duration) and University degrees (Bachelor of Science [BSc] /Master of Science [MSc] / Doctor of Philosophy [PhD]). Consequently, the content and quality of their eye examinations probably differ according to their competency level. The eye examination should include a patient history, examination of visual function, refraction, assessment of binocular vision and oculomotoric function, as well as examination of the eye and its surrounding structures. In cases of suspected eye disease or systemic disease affecting the eye or vision, optometrists are obliged to refer the patient to a medical doctor. It has been estimated that Norwegian optometrists perform more than one million

eye examinations per year, of which 4% result in referral to other healthcare providers [23].

3.3 Diabetes

In Norway, 90,000 to 120,000 people have diabetes. It is likely that as many more have undiagnosed diabetes [4], and even more are likely to have impaired glucose tolerance and impaired fasting glycaemia [24]

3.3.1 Diagnostic criteria for diabetes

The level of fasting plasma glucose employed as a diagnostic criterion for diabetes assumes a glycaemic threshold that identifies people at risk of microvascular complications [25]. The National professional guidelines: “Diabetes - Prevention, diagnostics and treatment” issued in April 2009 [26] uses the international diagnostic criteria for diabetes: fasting serum blood glucose ≥ 7.0 mmol/L and/or 2-hour serum blood glucose ≥ 11.1 mmol/L and/or chance serum blood glucose ≥ 11.1 mmol/L in combination with symptoms. In the general population, mild retinopathy is associated with Hemoglobin A1C (HbA_{1c}) - level, hypertension and abdominal obesity, which may indicate insulin resistance or associated factors as part of the pathogenesis of the retinopathy [27]. The diagnostic criteria for diabetes have been questioned, because diabetic retinopathy can occur in people without diabetes, that is, people with serum blood glucose below the diagnostic criteria for diabetes [28, 29]. Moreover, a recent study proposed that either the diagnostic level of fasting plasma glucose should be lowered to 6.5 mmol/L, or HbA_{1c} of 6.5% should be used as diagnostic criterion, based on a threshold for risk of *moderate* non-proliferative diabetic retinopathy or worse, which is specific for diabetes [30].

3.3.2 Late complications and practice guidelines

Diabetes may affect several organs or organ systems, including the eye. Late complications in diabetes include both macrovascular and microvascular disease. In persons with diabetes, cardiovascular disease is more frequent, has an earlier onset, and is more likely to have severe manifestations and complications. The triad of microvascular disease, nephropathy, neuropathy and retinopathy, however, is specific to diabetes [31]. Population-based studies have shown that diabetic retinopathy is related to hyperglycaemia, hypertension, high cholesterol, increased microalbumin, increased creatinine, abdominal obesity and increasing age [27, 30, 32-35]. Practice guidelines for diabetes state treatment targets aimed at preventing and delaying late complications. The National professional guidelines: “Diabetes - Prevention, diagnostics and treatment” define treatment targets for HbA_{1c}, fasting blood glucose, non-fasting blood glucose, body weight, serum low-density lipoprotein (S-LDL) -Cholesterol, blood pressure, physical activity, and smoking [26].

Diabetic retinopathy should be treated before symptoms occur [5]. To facilitate this, the National professional guidelines recommend regular eye examination [26]. Patients diagnosed with type 1 diabetes should have their first eye examination 5 years after diagnosis, then yearly thereafter, or every second year if plasma blood glucose and blood pressure are stable. Patients diagnosed with type 2 diabetes should have their first eye examination at the time of diagnosis, then annually thereafter, or biennially if plasma blood glucose and blood pressure are stable. If diabetic retinopathy is present, the importance of strict blood pressure regulation (blood pressure < 135/80 mmHg) and blood glucose control (HbA_{1c} < 7% mmol/l) is emphasised [26].

3.4 Ocular complications in diabetes

Diabetic retinopathy is the most feared ocular complication in diabetes. However, other aspects of the eye and visual function may also be affected [36-38]. Table 3.1 gives an overview of potential ocular complications in diabetes and associated ocular conditions. Visual acuity, refractive error, cataract and retinopathy are described in more detail below.

3.4.1 Visual acuity

In the general population, vision impairment, both correctable and uncorrectable, is more common in patients with diabetes [39]. Visual acuity can be affected due to the effect of hyperglycaemia on ocular structures. Variable and blurred vision can be experienced as a result of transient refractive changes, and reduced visual acuity can occur as a result of cataract and/or diabetic retinopathy.

3.4.2 Refractive error

Generally, hyperglycaemia does not alter the refractive properties of the healthy human eye. However, in patients with diabetes, hyperglycaemia can be associated with transient refractive changes, both myopic and hyperopic shifts [40]. Transient hyperopia can also occur during intensive glucose reduction, and normalisation of refraction may take months after the regulation of blood glucose [41]. Suggested causes of these transient refractive shifts are change in lens thickness, changes in lens shape and/or changes in refractive index [40, 41]. Additionally, permanent refractive change, usually towards myopia, can occur; these are likely to be due to increased thickness and curvature of the lens [36]. Only marginal changes in refractive error and higher order aberrations have been demonstrated in patients complaining of blurred vision. This may indicate that blurred vision is also influenced by other factors, such as changes in the retina or visual cortex, or it may indicate that changes in refraction, higher order

aberrations, and shape of the cornea/lens are related to the severity and duration hyperglycaemia [42]. In patients with newly diagnosed diabetes, or with poorly controlled diabetes, it is advisable to postpone the issue of a new prescription until glycaemic control is well established [37].

3.4.3 Cataract

The association between diabetes and cataract has been well documented in large cross-sectional and prospective population-based studies [43-46]. Diabetes is associated with the prevalence and progression of posterior subcapsular cataract and cortical cataract, but not with nuclear cataract [43-46]. Cataract occur at a younger age and progress more rapidly in patients with diabetes [47]. The risk of cataract increases with increasing duration of disease and severity of hyperglycaemia [48]. Impaired glucose tolerance has been shown to be a risk factor for development of cortical cataract [49]. The visual outcomes of cataract surgery may be poorer in patients with diabetes than in patients without diabetes, and adequate laser treatment of retinopathy is required before cataract surgery [38].

Table 3.1 Overview of ocular complications and associations of diabetes

OCULAR COMPLICATIONS AND OCULAR ASSOCIATIONS

Refraction and visual function	**Signs and symptoms**	**Possible cause**
Refraction	Transient change	Refractive index of lens
	Permanent change	Lens curvature and thickness
Best corrected visual acuity	Reduced visual acuity	Cataract
		Clinically significant macula oedema
		Vitreous haemorrhage
Colour vision	Tritan colour vision defect	
Contrast sensitivity	Reduced contrast sensitivity	
Visual field	Metamorphopsia	Clinically significant macula oedema
	Scotoma	Vitreous / preretinal haemorrhage
		Vascular occlusion
Cover test and ocular motility	Diplopia / Tropia	III. IV. or IV. cranial nerve palsy
Ocular structure and function	**Signs and symptoms**	**Possible cause**
Pupillary reflex	Miosis	Neuropathy
	Mydriasis	Iris rubeosis
	Relative afferent pupillary defect	
	Light-near dissociation	
Lids	Meibomian gland dysfunction	
	Stye	
	Blepharitis	
Cornea	Reduced corneal sensitivity	Neuropathy and vasculopathy
	Persistent epithelial defects	Posttraumatic
	Erosions and ulcers	Abnormalities of corneal epithelium
	Infections	
Iris	Neovascularisation	
Lens	Cataract	
Vitreous	Vitreous haemorrhage	
	Posterior vitreous detachment	
Optic nerve	Diabetic Retinopathy	
	Anterior Ischaemic Optic Neuropathy	
	Diabetic papillopathy	
Macula	Diabetic retinopathy and macular oedema	
Retina	Diabetic retinopathy	
	Retinal detachment	
Diabetes is a known risk factor	**Signs and symptoms**	**Possible cause**
Glaucoma	Visual field defects	Increase susceptibility to nerve damage
Primary open-angle glaucoma		
Neovascular glaucoma		Impaired blood flow / vascular perfusion
Angle-closure glaucoma		Neovascularisation
		Increased lens thickness/autonomic dysfunction
Ocular ischemic syndrome	Vision loss	Internal carotid/ophthalmic artery occlusion
Diabetes is a possible risk factor		
Retinal vein occlusion	Acute vision loss	Non-ischaemic (30%) or ischaemic
	Mimic diabetic retinopathy	
Retinal arteriolar embolus	Transient ischaemic attack	Discrete plaque-like lesions
Retinal artery occlusion	Sudden, unilateral painless vision loss	
Corneal disease	Pain, photophobia, blurred vision	Abnormalities of corneal epithelium
	Hyperaemia	Reduced corneal sensitivity
Mimics of diabetic retinopathy		
Age-related macular degeneration	Wet AMD	Increased expression of VEGFs
		Chronic inflammation
Hypertensive retinopathy	Severe signs	Hypertension
Radiation retinopathy	Delayed onset	
	Identical to diabetic retinopathy	

3.4.4 Diabetic retinopathy

Most patients with diabetes will develop some degree of diabetic retinopathy [50-53] and around one third will develop some degree of diabetic macular oedema [51, 54-56]. The reported prevalence of diabetic retinopathy differs widely [57]. In international population-based studies, the prevalence of diabetic retinopathy ranges from 24% to 36% in patients with known diabetes [32, 33, 58-62] and from 3% to 16% in patients with newly diagnosed diabetes [29, 32, 33, 62, 63]. The prevalence of sight-threatening diabetic retinopathy is lower, ranging from 1% to 13% [33, 58, 60-62, 64, 65]. The general prevalence of diabetic retinopathy has decreased in recent years, possibly due to improvements in primary care in terms of the use of eye care services, monitoring of glucose levels and blood pressure, and treatment of hypertension [66, 67]. In Norway, the prevalence of retinopathy is sparsely described. The Eigersund study found a general prevalence of diabetic retinopathy of 14% (34% and 10% in type 1 and type 2 diabetes, respectively) [68]. A recent screening study undertaken in Tønsberg, Stavanger and Tromsø found a prevalence of any retinopathy of 28% (66% and 24% in type 1 and type 2 diabetes, respectively) [64]. The most recent study, the Tromso Eye Study reported a prevalence of diabetic retinopathy of 27% and a prevalence of macular oedema of 4% [69]

Early detection and prompt treatment of sight-threatening retinopathy are fundamental goals in the prevention of visual impairment in diabetes. An international clinical classification system, the “International Clinical Diabetic Retinopathy and Diabetic Macular Edema Disease Severity Scale”, has been developed to improve screening and communication between healthcare providers [70]. A summary of the classification is outlined in Table 3.2. The retinopathy grading includes five levels, three with relatively low risk of visual loss

and two with relatively high risk of visual loss. The grading of macular oedema consists of two steps to accommodate for variation in examiner education and available equipment: (1) the presence/absence of retinal thickening in the posterior pole, and (2) oedema severity (mild, moderate or severe).

Table 3.2 Classification of diabetic retinopathy and diabetic macular oedema

Diabetic Retinopathy Disease Severity Scale

Severity level	**Findings on dilated ophthalmoscopy**
No apparent retinopathy	No abnormalities
Non-proliferative diabetic retinopathy	Microaneurysms only
Moderate non-proliferative diabetic	More than just microaneurysms but less than severe non-
Severe non-proliferative diabetic retinopathy (4:2:1)	Any of the following: More than 20 intraretinal haemorrhages in each of 4 quadrants Definite venous beading in 2+ quadrants Prominent intraretinal microvascular abnormalities in 1+ quadrant And no sign of proliferative retinopathy
Proliferative diabetic retinopathy	One or more of the following: Neovascularisation Vitreous/preretinal haemorrhage

Diabetic Macular Edema Disease Severity Scale

Severity level Diabetic macular oedema apparently absent	**Findings on dilated ophthalmoscopy*** No apparent retinal thickening or hard exudates in posterior pole
Diabetic macular oedema apparently present	Some apparent retinal thickening or hard exudates in posterior pole
Mild	Some retinal thickening or hard exudates in posterior pole but distant from the centre of the macula
Moderate	Retinal thickening or hard exudates approaching the centre of the macula but not involving the centre
Severe	Retinal thickening or hard exudates involving the centre of the macula

* Hard exudates are a sign of current or previous macular oedema. Diabetic macular oedema is defined as retinal thickening, and this requires a three-dimensional assessment that is best performed by dilated examination using slit-lamp biomicroscopy and/or stereo fundus photography. (From International Clinical Diabetic Retinopathy and Diabetic Macular Edema Disease Severity Scale [70])

Development and progression of diabetic retinopathy and diabetic macular oedema is associated with diabetes duration [51, 54, 71-73], hyperglycaemia [27, 51, 54-56, 71-74], hypertension [27, 51, 55, 71, 72, 74, 75], and hyperlipidaemia [74, 76, 77]. However, epidemiological studies have failed to show a consistent association between serum lipid levels and diabetic retinopathy [78]. Current

treatment of diabetic retinopathy includes systemic control of diabetes, surgical therapy and pharmaceutical therapy [79, 80]. Intervention studies (the UK Prospective Diabetes Study, UKPDS, and the Diabetes Control and Complications Trial, DCCT) have shown that intensive control of glucose levels [81-83] and strict blood pressure control (UKPDS) [84] reduces the risk of the occurrence and progression of diabetic retinopathy. The Fenofibrate Intervention and Event Lowering in Diabetes study (FIELD) and the Action to Control Cardiovascular Risk in Diabetes trial (ACCORD) have shown that lipid lowering therapy is protective against the development and progression of diabetic retinopathy and the development of macular oedema [78, 85, 86]. Laser photocoagulation of proliferative diabetic retinopathy and clinically significant macular oedema reduces the risk of visual loss by 50% to 70% [87, 88]. A recent review [80] proposed the following clinical recommendations for surgical and pharmaceutical interventions for diabetic retinopathy: (1) panretinal photocoagulation is indicated in high risk proliferative diabetic retinopathy, and in early proliferative retinopathy and severe non-proliferative diabetic retinopathy if additional risk factors are present, (2) focal laser photocoagulation is indicated in clinical significant macular oedema involving the centre of the macula and affecting vision, (3) vitrectomy is (i) recommended in patients with severe vitreous haemorrhage and significant diabetic retinopathy, (ii) should be considered in eyes with severe proliferative diabetic retinopathy not responding to extensive panretinal photocoagulation, and (iii) can be beneficial in patients with diffuse macular oedema not responding to other treatments, and (4) intravitreal steroids and intravitreal anti-vascular endothelial growth factor agents may have a role in reducing macular oedema and reversing neovascularisation.

3.5 Visual impairment

VISION 2020 is a global initiative for the elimination of avoidable blindness, defined as “blindness which could be either treated or prevented by known, cost-effective means” [89]. The initiative was launched by the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB), with international memberships of non-governmental organizations, professional associations, eye care institutions and corporations. It is estimated that up to 80% of the world's blindness is avoidable [90]; moreover, diabetic retinopathy is addressed by VISION 2020 as one of the main causes of avoidable blindness [89].

3.5.1 Definitions of visual impairment

Visual impairment is defined by the WHO in the International statistical classification of diseases, injuries and causes of death, 10th revision (ICD-10) [91]. Low vision is defined as BCVA of at least 0.05 but less than 0.33; blindness is defined as BCVA of less than 0.05. However, other terms and other definitions of visual impairment are commonly used in clinical practice and in the literature. These terms and definitions originate from legal acts and research studies. In the United States, the Social Security Act of 1935 defines legal blindness as BCVA of less than or equal to 0.1 [92]; in the United Kingdom, the National Assistance Act of 1948 defines blindness as BCVA of less than or equal to 0.05 and partial sight as BCVA of less than 0.33 [93]. In Norway, the National Insurance Act defines low vision as BCVA of less than 0.33 [63]. Population studies have defined visual impairment as BCVA of less than 0.5 [94]. This also defines the visual acuity (VA) criterion for driving a private car (total weight ≤ 3500 kg and up to eight passenger seats) in Norway [95]. Correctable visual impairment has been defined as VA of less than 0.5 in the better eye before refraction (habitual visual

acuity [HVA]) which improves to no visual impairment (that is, BCVA of greater than or equal to 0.5) after refraction [96].

3.5.2 Epidemiology of visual impairment

The estimated number of visually impaired people in the world (using the WHO definition) is 285 million (4.24%), of whom 246 million (3.65%) have low vision (0.05<BCVA<0.33) and 39 million (0.58%) are blind (BCVA<0.05) [90]. The world leading cause of visual impairment is uncorrected refractive errors (43%) followed by cataract (33%), glaucoma (2%), age-related macular degeneration (1%), diabetic retinopathy (1%), corneal opacities (1%) and trachoma (1%). The leading causes of blindness are cataract (51%), glaucoma (8%), age-related macular degeneration (5%), childhood blindness and corneal opacities (4%), refractive errors and trachoma (3%) and diabetic retinopathy (1%) [90].

In Western Europe, the prevalence of visual impairment is lower, with 1.3% having low vision (0.05<BCVA<0.33) and 0.2% being blind (BCVA<0.05) [97]. However, blindness and partial sight registrations due to age-related macular degeneration and diabetic retinopathy are increasing [98-100]. The most important causes of blindness are age-related macular degeneration (50%), glaucoma (18%) and diabetic retinopathy (17%) [97]. In the Nordic countries, the reported prevalence of visual impairment (BCVA<0.5) and blindness (BCVA<0.1) is 0.7% to 2.0% and 0.5% to 1.0%, respectively. The main causes of visual impairment are age-related macular degeneration, cataract, diabetic retinopathy and glaucoma [101-103].

The prevalence of visual impairment and eye disease increases with increasing age, and the majority of the visually impaired (BCVA<0.5) are 65 years or older [101, 104-109]. There is no national register of blind and partially sighted people

in Norway and no accurate estimate of the prevalence of visual impairment and eye disease among the Norwegian population. Population-based studies report that 1% to 6% of the general adult population have correctable visual impairment [96, 104, 110-112] and the prevalence of correctable visual impairment increases with increasing age [104, 113, 114]. Table 3.3 shows estimates of visual impairment and eye disease among Norwegians older than 49 years, based on estimated data from the Eye Disease Prevalence Research Group for Western-Europe [115-119].

Table 3.3 Estimated numbers of people older than 49 years with visual impairment and eye disease in Norway

		Estimated number of people		
	Estimated prevalence (%)*	All	Female	Male
Visual impairment (BCVA<0.5)	2.0	33,087	17,312	15,775
Blindness (BCVA<0.05)	0.5	8,.272	4,328	3,944
Cataract	25.4	420,207	219,865	200,342
Diabetic retinopathy	4.0	66,174	34,624	31,550
Age-related macular degeneration	2.5	41,359	21,640	19,719
Glaucoma	2.1	34,742	18,178	16,564

* Based on estimated data from the Eye Disease Prevalence Research Group for Western-Europe [115-119]

3.5.3 Visual impairment in diabetes

In the general population within Western societies, 5% to 13% of blind and partial sight registrations are due to diabetic retinopathy [5, 98, 99, 101, 120, 121]. In patients with diabetes, the prevalence of visual impairment due to diabetic retinopathy is 0.4% to 1.6% [59-61, 69, 122-125]. However, 3% to 9% of patients with diabetes have visual impairment attributable to concurrent ocular disease [59, 122].

In patients with type 1 diabetes, the 25-year incidence of proliferative diabetic retinopathy is 42% to 43% [53, 67]. Even with screening for diabetic retinopathy and laser treatment of sight-threatening retinopathy, blindness is still a serious

issue [126]. The 25-year incidence of blindness and visual impairment in patients with type 1 diabetes is 3% to 9% [53, 67] and 13% [127], respectively. Maculopathy and poor glycaemic control are both risk factors for the development of blindness [126]. Improved glycaemic and blood pressure control and avoidance of smoking may reduce visual impairment [127]. A lower risk of proliferative diabetic retinopathy in recently diagnosed patients may reflect improvements in care [67].

Diabetic retinopathy is estimated to occur 4 to 7 years prior to a clinical diagnosis of type 2 diabetes [128]. In type 2 diabetes, the reported 10-year incidence of any retinopathy is 50% [129] and the reported 4-year incidence of sight-threatening retinopathy is 2% [130]. Despite regular eye examinations and laser treatment of sight-threatening retinopathy, a small number of older patients with type 2 diabetes become visually impaired due to unsuccessful photocoagulation of macular oedema [131]. The reported five-year incidence of blindness and visual impairment is 0.6% and 1.7 %, respectively [132]. Moreover, in patients with type 2 diabetes, vision deteriorates significantly during the first six years after diagnosis. This is primarily dependent on the age of the patient and the presence of age-related macular degeneration, diabetic retinopathy and cataract at the time of diagnosis [133].

3.6 Eye examination in diabetes

3.6.1 Definitions

Screening can be targeted at a population (mass screening), a specific risk group (prescriptive screening) or at individuals who for other reasons attend a setting where screening may occur (opportunistic screening) [134]. Screening is defined as: “Examination of a group of usually asymptomatic individuals to detect those with a high probability of having a given disease, typically by means of an inexpensive diagnostic test” [135]. In contrast, case-finding is defined as “secondary prevention through early detection of cases among persons using health services for other reasons, e.g., checking blood pressures of all patients who attend a physician’s office” [136]. Optometric practice provides a natural setting for *case-finding* of ocular disease and ocular complications of systemic disease, and could be a potential setting for *prescriptive screening* for diabetic retinopathy in patients with diabetes.

Sensitivity and specificity define the ability of a clinical test to correctly identify persons with and without disease. Sensitivity and specificity are independent of the population examined. However, the positive and negative predictive power of a test, that is, the chance that a positive or negative test result will be correct, depends on the prevalence of the disease in the examined population. For diseases with low prevalence a negative test result is likely to be correct, consequently a high specificity is required to avoid large numbers of false positives [137]. The British Diabetic Association (now Diabetes UK) has set a required screening standard for diabetic retinopathy of at least 80% sensitivity and 95% specificity [138].

3.6.2 St. Vincent Declaration and screening for diabetic retinopathy

The St. Vincent Declaration (1989) states general goals for patients with diabetes in terms of (1) improvements in health experience and life expectancy, and (2) prevention and cure of diabetes and its complications [139]. The statement was made after a meeting held in St. Vincent, Italy, between diabetes experts and representatives of Government Health Departments and patient organisations from all the European countries. The meeting was supported by the WHO and the International Diabetes Federation.

The St. Vincent Declaration stated, as a specific goal in plans for prevention, identification and treatment of diabetes and its complications, that it would aim to "reduce new blindness due to diabetes by one-third or more" [139]. Most cases of visual loss can be prevented by regular eye examination and early treatment of diabetic retinopathy [6, 124, 140-142]. Screening for diabetic retinopathy is shown to be more cost-effective than many other routine interventions for detecting and treating disease [7]. Mydriatic retinal photography, with additional use of ophthalmoscopy for cases with ungradeable retinal photographs, is the most effective method for screening and monitoring diabetic retinopathy [143], in terms of sensitivity for detecting sight-threatening retinopathy and likelihood of achieving an overall sensitivity greater than 80% within the screening programme. The most robust screening method is digital mydriatic retinal photography [144], which has the additional advantages of instant viewing and repeat photography, the possibility of electronic transfer, and the facility for patient education and involvement. The establishment of a robust screening programme and training strategy for healthcare professionals requires substantial organisation and commitment from all parties involved, as well as good patient education [144].

Studies have shown that optometrists are able to detect and grade diabetic retinopathy. A study, undertaken at Queensland University of Technology (Australia), of randomly selected members of the Optometrists Association Australia Queensland Division (n=19) showed a sensitivity and specificity of 94.1% and 97.4%, respectively for detection of diabetic retinopathy based on retinal slide assessment. The sensitivity of retinopathy grading was 66.8%. Based on ophthalmoscopy, the sensitivity and specificity for detection of retinopathy was 93.9% and 92.1%, respectively. Retinopathies were correctly classified in 64.5% of cases[8]. A Welsh study showed improved sensitivity for detection of any diabetic retinopathy (73.9% versus 88.2%) and sight-threatening retinopathy (82.2% versus 91.1%) by community optometrists using 35 mm retinal slides compared to dilated direct ophthalmoscopy [145]. Moreover, the study showed higher sensitivity for a specially trained optometrist compared to the community optometrists (97.2% versus 91.1%). Optometrists (n=13) involved in a screening programme in St Helens and Knowsley (UK) using dilated indirect ophthalmoscopy, had a sensitivity and specificity for detecting *any* diabetic retinopathy of 72% and 77%, respectively [10]. For UK optometrists (from the Wirral, St Helens and Knowsley, and Aberdeen) specially trained to take part in screening for diabetic retinopathy, the reported sensitivity and specificity for detecting s*ight-threatening* diabetic retinopathy was 73% to 87% and 90% to 95%, respectively [9-11].

The level of optometric education and scope of optometry in Australia and the UK differ from the basic optometric education and scope of optometry in Norway. Therefore, Norwegian optometrists may not demonstrate this level of diagnostic accuracy when screening for diabetic retinopathy.

3.6.3 Knowledge and utilisation of eye care in diabetes

A study undertaken in 1996 indicated that only 53% of patients with diabetes in Norway were referred by general practitioners to an ophthalmologist for an eye examination. Furthermore, only 37% had been examined by an ophthalmologist during the previous year [146]. Improved eye care in patients with diabetes has been reported in the US (1988-2002) [147], Australia (2003-2005) [148] and Germany (1999-2008) [149]. Utilisation of eye care services is associated with the use of health care services in general and is increased by health promotion campaigns [148, 150, 151]. Recent cross-sectional surveys of the general diabetic population in Germany, the UK, Australia and the US have shown that 63% to 77% of patients with diabetes have their eyes examined according to existing guidelines [147, 149-152]. Current studies also indicate improved eye care in Norway from 1996 to 2005/2007, with 69% to 71% attending regular eye examinations by 2005/2007 [64, 153].

3.7 Questions unanswered

The Norwegian health services research in the field of eye and vision care has been limited. The prevalence of visual impairment and the prevalence of diabetic retinopathy among patients with diabetes in Norway are sparsely described. There are limited data regarding factors associated with retinopathy, concurrent ocular disease, current eye care and compliance to eye examination guidelines. In the Norwegian health care system, optometrists do not have a formal role in the care of patients with diabetes and there are no accurate data regarding Norwegian optometric practice in terms of the patients examined, the eye examinations undertaken, and the optometrists' referral practice. To my knowledge, there have so far been no descriptions of optometric practice based on large national studies with representative samples of optometrists and their patients. Nor have there been any large national, or international, studies that describe the diagnosis, management and referral of retinopathy in optometric practice.

It is in the patients' best interest that their vision and ocular health is managed in a safe and proper manner. The lack of an established system for eye examination in diabetes and the lack of information about current ocular care in patients with diabetes in Norway provides inspiration to explore: (1) optometric practice with a focus on the eye examination, visual function and retinopathy of the patients examined, and the optometrists' patient management routine, and (2) vision and ocular health in patients with diabetes.

4. Aims

The overall aim of this thesis was to contribute to the existing knowledge of Norwegian optometry and the management of vision and ocular health in patients with diabetes in Norway in terms of health services research.

The thesis had four main objectives:

1. to describe Norwegian optometric practice in terms of optometrist and patient characteristics, the routine eye examination, and the collaboration between optometrists and general practitioners and ophthalmologists
2. to establish the prevalence of visual impairment and case-finding of suspected retinopathies in patients examined in optometric practice, to explore the patient-reported prevalence of diabetic retinopathy and visual impairment in patients with diabetes, and to analyse predictors of retinopathy
3. to evaluate the optometrists' retinal assessment and their diagnostic quality of assessment of diabetic retinopathy
4. to assess compliance with recommended eye care guidelines and to assess variables associated with regular eye examination, in patients with diabetes

In Papers I and II, the aims were:

1. to describe Norwegian optometric practice and optometrists
2. to describe characteristics of the patients who are examined Norwegian optometric practice
3. to establish the prevalence of patient-reported diabetes in optometric practice

4. to explore the prevalence of visual impairment among patients seen for a routine eye examination in optometric practice
5. to explore the rate of case-finding of ocular disease, in particular suspected retinopathies, during routine eye examination in optometric practice
6. to analyse associations with suspected retinopathies detected in optometric practice
7. to determine the proportion of previously unobserved signs of ocular and systemic disease detected by routine eye examination in optometric practice
8. to assess how optometrists deal with patients who have clinical signs of ocular disease and ocular complications of systemic disease
9. to explore the optometrist's collaboration with general practitioners and ophthalmologists

In Paper III, the aims were:

1. to describe and analyse eye care among members of the NDA who had diabetes
2. to explore available sources of information regarding eye care among patients with diabetes
3. to assess reported eye care in relation to established practice guidelines
4. to analyse and identify variables associated with eye care according to guidelines in patients with diabetes

In Paper IV, the aims were:

1. to describe the prevalence of retinopathy consistent with diabetic retinopathy in people with diabetes, impaired glucose tolerance and normal glucose tolerance

2. to describe the prevalence of visual impairment in people with diabetes, impaired glucose tolerance and normal glucose tolerance
3. to investigate predictors of retinopathy consistent with diabetic retinopathy
4. to explore the rate of regular eye examination in people with diabetes, impaired glucose tolerance and normal glucose tolerance

In Paper V, the aims were:

1. to assess the diagnostic sensitivity and specificity of optometrists' retinal image evaluation of diabetic retinopathy
2. to describe how optometrists would manage and follow-up patients based on retinal image evaluation of diabetic retinopathy.

5. Methods

5.1 Definition of terms

5.1.1 Optometric practice

In this thesis, optometric practice is limited to private, clinical practice. Optometric practice includes the practicing optometrists, their patients, the eye examination, and the collaboration with general practitioners and ophthalmologists.

5.1.2 Visual impairment and correctable visual impairment

Visual impairment was defined by BCVA in the better eye, as described in 3.5.1: (1) visual impairment, BCVA < 0.5, (2) low vision, BCVA < 0.33, (3) blindness, BCVA < 0.05 and (4) correctable visual impairment, HVA < 0.5 improving with refraction to BCVA ≥ 0.5. Furthermore, reduced functional vision was defined as BCVA in the better eye < 0.8, corresponding to the visual acuity criteria for driving heavy vehicles, trucks and buses in Norway [95].

5.1.3 Retinopathy and diabetic retinopathy

Retinopathy was used as label for any disease abnormality affecting the retina and was divided into macular disease, diabetic retinopathy and hypertensive/vascular retinopathy. Diabetic retinopathy was graded in accordance with the International Clinical Diabetic Retinopathy and Diabetic Macular Edema Disease Severity Scale, Table 3.2 [70].

5.1.4 Screening and case-finding

The terms screening and case-finding are defined in 3.6.1. In this thesis, the term screening is used to describe prescriptive screening, that is, regular retinal examination for diabetic retinopathy in patients with diabetes. The term case-finding is used to describe opportunistic screening, in specific retinal examination

in patients who attend optometric practice for routine eye examination. The term screen-detected diabetes defines diabetes identified by mass screening, including an oral glucose tolerance test, in a sample of the general adult population.

5.2 Study design

This thesis consists of five studies. All studies had a cross-sectional design. Table 5.1 lists the main aims of the thesis, categorised by the Papers (I-V) addressing them and the materials and methods used. Figure 5.1 shows the study populations and designs used in Papers I-V.

Table 5.1 Aims of the thesis categorised by research method and referring Papers (I-V)

	Methods	Sample size (n)	Paper
Norwegian optometric practice			
Optometrists and routine examination in optometric practice	Questionnaire	508	I
General patients examined in optometric practice	PRF	4,052	I
Patients with diabetes examined in optometric practice	PRF	166	II
Detection and management of suspected retinopathies	PRF	212	II
Visual impairment and retinopathy			
Visual impairment in patients examined in optometric practice			
General patients examined in optometric practice	PRF	4,052	I
Visual impairment and visual symptoms in patients with diabetes			
Patients examined in optometric practice (visual acuity)	PRF	166	II
Members of a national diabetes organization (visual	Questionnaire	1,352	III
People from the HUNT survey (visual symptoms and visual	Questionnaire	20	IV
Diabetic retinopathy and suspected diabetic retinopathy			
Self-reported and suspected retinopathies among patients seen in optometric practice	PRF	4,052	II
Self-reported prevalence among members of a national diabetes organisation	Questionnaire	1,352	III
Diabetic retinopathy found in a sample of people from the HUNT survey	Clinical examination	126	IV
Optometrists' retinal assessment and diagnostic quality of case-finding of diabetic retinopathy			
Optometrists' routine examination	Questionnaire	508	I
Detection of suspected retinopathies	PRF	212	II
Sensitivity and specificity of optometrists' image assessment for diabetic retinopathy	VIMOC examination	74	V
Management of vision and ocular health in diabetes			
Eye examination in members of a national diabetes organisation	Questionnaire	1,352	III
Eye examination in patients with diabetes in a general	Questionnaire	20	IV

PRF, practice registration form, VIMOC, Visual Identification and Management of Ophthalmological Conditions

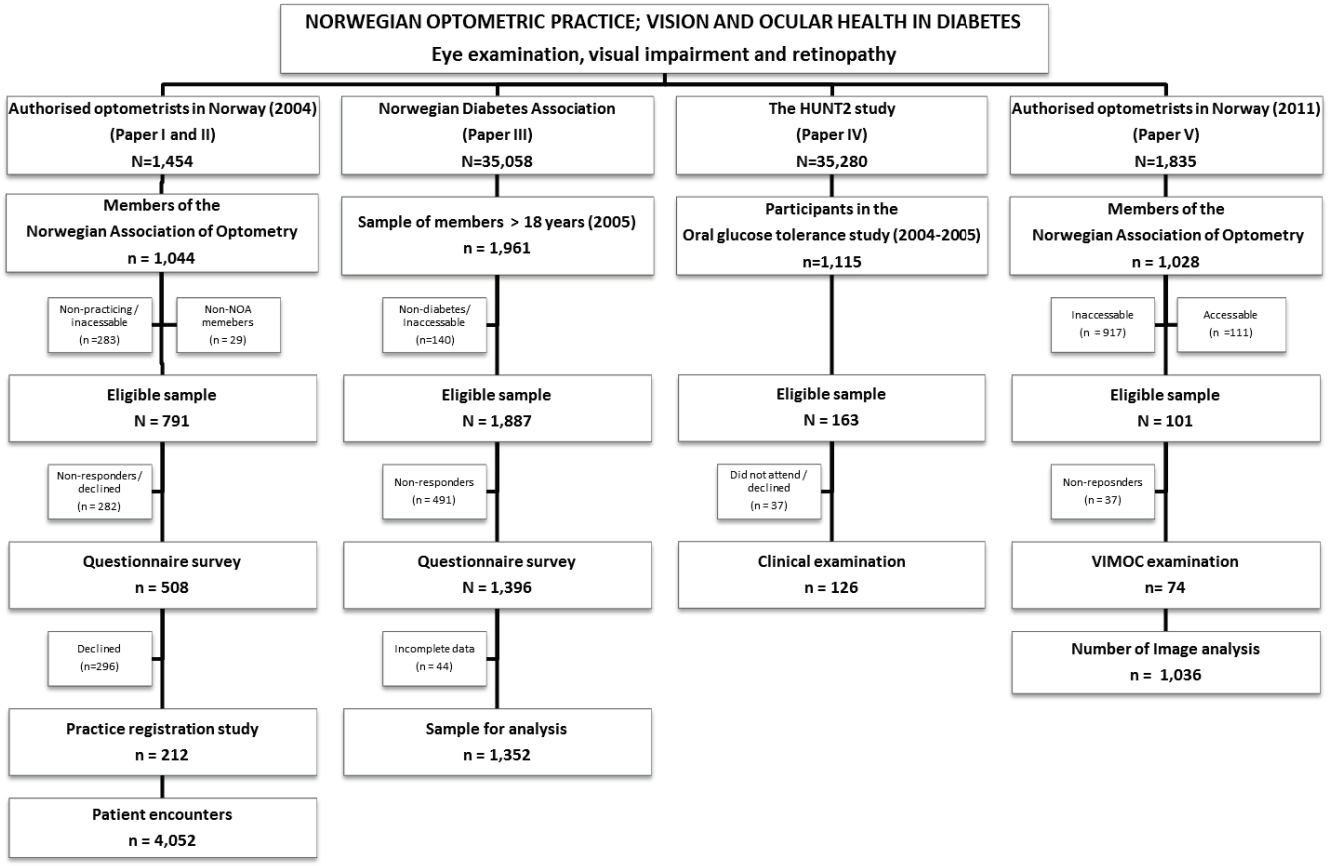


Figure 5.1 Materials and methods used in Papers I-V

NOF, Norwegian Association of Optometry; GLUP, glucose tolerance study; HUNT, the Nord-Trøndelag Health Study

5.3 Study population and study samples

5.3.1 Papers I and II

At the time of the studies, 1,454 optometrists were registered with the Norwegian Registration Authority for Health Personnel (Norwegian Board of Health, 01.06.2005). However, the Norwegian Registration Authority for Health Personnel did not have a current address register. Therefore, an address list of members of the NOF (n=1,044) was obtained (NOF, 26.10.2004). All members of the Norwegian Association of Optometrists working in private optometric practice (n=761) were invited to participate in a questionnaire survey. Members working in hospitals, low vision clinics, the educational system or industry, as well as members who were retired, unemployed, on leave, not practicing optometry, living abroad, or without a known residential address, were excluded. In addition, 29 practising, non-association member optometrists, who heard about the study and volunteered to participate, were included, giving an eligible sample of 790. All questionnaire respondents were asked to complete the practice registration form, on which they were asked to record details for 20 consecutive patients seen for a full eye examination. Patients seen for contact lens fitting or contact lens follow-up were not included in the registration form. There were two reasons for this exclusion. First, contact lens fitting is a specialised qualification in Norway. Second, the routine for contact lens fitting and follow-up differs from the routine eye examination in terms of content and follow-up routines.

5.3.2 Paper III

The NDA is a voluntary, independent organisation with the stated objective of serving patients with diabetes and others who have an interest in diabetes. At the time of the study, the NDA had the only national registry of adults with diabetes in Norway. In 2005, it had 35,058 members, consisting mainly of patients with diabetes, but also some of their relatives (approximately 900) and some healthcare professionals (approximately

3,000). A random sample of members of the NDA aged 18 years and older (n=1,961) was invited to participate in the questionnaire survey. People without diabetes, deceased members, and members either without a known address or with an overseas address, were excluded, leaving an eligible sample of 1,887.

5.3.3 Paper IV

A sample from a population-based screening survey undertaken in Verdal, Norway in 2004-2005 was used. The screening survey investigated the prevalence of undiagnosed cases of hyperglycaemia (according to WHO's criteria [154]) in a general Norwegian population. In short, a random sample (n=2,000) of the population aged 20 years and older were invited to undertake an oral glucose tolerance test. In total, 1,115 (56%) people completed the test. In our study, we invited 163 people from the screening survey to a follow-up eye examination in 2005. All available participants with known diabetes (n=24) and screen-detected diabetes (n=50) were included. In addition, a random sample of participants with impaired glucose tolerance (n=46), and an age- and gender-matched sample of participants with normoglycaemia (n=43) were invited. Baseline information for the participants was accessible through the second Nord-Trøndelag Health Study (HUNT2) [155].

5.3.4 Paper V

At the time of the study, 1,835 optometrists were registered with the Norwegian Registration Authority for Health Personnel (Norwegian Board of Health, 01.06.2011).
All full members of the NOF (n=1028) were invited to participate by personal e-mail. Optometrists who were currently working in private practice and had worked in private practice for the previous 6 months and intended to continue to work in private practice for the following 6 months, were eligible for inclusion in the study. In all, 112 (11%) optometrists responded positively to the e-mail and volunteered to participate, 11(10%) did not meet the inclusion criteria, leaving an eligible sample of 101.

5.4 Data collection

Data for all studies were collected in the period November 2004 to February 2011. The information was collected by questionnaires, practice registration forms, clinical examination and VIMOC examinations. A VIMOC examination tests clinical competency using images with accompanying multiple choice questions. The questionnaires were completed by Norwegian optometrists and patients with diabetes in Norway. The practice registration form was completed by optometrists in private optometric practice in Norway. The clinical examination was undertaken in a sample from the HUNT-study in Verdal, Nord-Trøndelag. The VIMOC examination was completed by a sample of optometrists in private optometric practice in Norway.

5.4.1 Papers I and II

In Papers I and II we used a questionnaire (Appendix 1) and a practice registration form (Appendix 2). Both were completed by Norwegian optometrists working in private clinical practice. The questionnaire included questions about the nature of the practice, education and work experience, practice habits, and opinions on important principles of practice. On the practice registration form, optometrists were asked to record details for 20 consecutive patients seen for a full eye examination. The details recorded were patient history, BCVA, ocular health and further patient management. The questionnaire and the practice registration form were tested in a pilot study involving twelve optometrists, reporting 240 patient encounters, in Kongsberg. The optometrists considered the questionnaire and practice registration form, with accompanying instructions, to be easy to understand. Only minor adjustments of language style were made as a result of the pilot study. The invitation to participate in the survey, including the questionnaire and the practice registration form, were sent to the optometrists in November 2004. Reminders were sent twice, in December 2004 and January 2005. In addition, telephone, e-mail, and the optometrists' internet discussion forum were used to improve the response rate. A final call for responses was made in June 2005.

5.4.2 Paper III

Study three comprised a postal questionnaire (Appendix 3) completed by those members of the NDA who had diabetes. The questionnaire included questions about: (1) care of vision and ocular health, (2) history of ocular disease and visual symptoms, and (3) type of diabetes, year of diagnosis, treatment, blood glucose stability, most recently recorded HbA_{1c} and blood pressure levels, details of any antihypertensive and cholesterol lowering medication taken, and current and previous smoking habits. The patient questionnaire was tested in a pilot-study involving thirty-two patients with diabetes in Kongsberg; all were members of the NDA. The pilot study led to the inclusion of a question regarding the source of information detailing the importance of regular eye examinations. Overall, answers from the pilot-study indicated that the questions were regarded as relevant and easy to comprehend. A random sample, computer-drawn from the NDA membership registry, was sent a postal invitation to participate in the survey, including the questionnaire, in October 2005. Reminders were sent to all invitees in December 2005.

5.4.3 Paper IV

In Paper IV, we used a questionnaire (Appendix 4), a standardised eye examination and registration form (Appendix5), and standardised registration form for analysis of retinal photographs (Appendix 6). The questionnaire was completed by patients with diabetes. The questionnaire was identical to the questionnaire in Paper III. The clinical examination was performed on all participants by two experienced optometrists. The clinical examination included a history of visual symptoms, ocular disease, vision and eye examination, measurement of HVA and BCVA, assessment of the crystalline lens and non-mydriatic fundus photography. The clinical examination was developed from a clinical examination undertaken in thirty-two patients with diabetes as part of a bachelors student's project ("Prevalence of ocular changes in patients with type 2 diabetes") [156]. The author initiated the bachelor's student's project, planned the design of the study,

and supervised the student during data collection, data analysis and project report writing. Analysis of the retinal photographs was performed by two ophthalmologists. The images were viewed on a 21" monitor with screen resolution of 1600x1200. The retinal photographs were analysed and graded with regard to: (1) presence of retinopathy, (2) type of retinopathy and (3) severity of diabetic retinopathy. The severity of diabetic retinopathy was graded according to the Diabetic Retinopathy Disease Severity Scale [70]. Analysis and grading were undertaken independently by the two ophthalmologists, who were blinded to information about the study participants. Baseline information for the participants was provided by the Nord-Trøndelag Health Study. The study sample was sent an invitation to participate in October 2005. The invitation included information about the study, a written consent form, and an appointment time for the clinical examination. The appointment time was available for rescheduling on request. Reminders were not sent.

5.4.4 Paper V

Paper V employed a web-based VIMOC examination (Appendix 7). The examination was completed by members of the NOF. The VIMOC examination had an experimental design consisting of 14 retinal images which were to be assessed with respect to: (1) presence or absence of diabetic retinopathy, and (2) appropriate patient management. No patient information was provided and the optometrists were to assume that the patient was not under the care of an ophthalmologist. The optometrists had no information about the patient's visual acuity and they were not provided with patient management guidelines. The retinal images were provided from the clinical study in Paper IV. Only images with full grading agreement between the two ophthalmologists were included. The ophthalmologists' diagnostic conclusion for each image was then used as a diagnostic gold standard. Seven images graded to represent non-proliferative diabetic retinopathy and seven images without diabetic retinopathy were randomly selected. A 50% occurrence of diabetic retinopathy was used to reduce the possibility of

producing false high specificity by chance. The sample size was based on the following assumptions to allow maximum variance: a 50% prevalence of diabetic retinopathy, a standard deviation of true sensitivity and specificity for the individual optometrists' image evaluation of 0.2, and individual optometrist sensitivity and specificity of 50%. This allowed sensitivity and specificity for any diabetic retinopathy to be calculated with a confidence interval of < 0.05 with a sample of 100 optometrists. The optometrists were not asked to grade the retinopathy and the sensitivity of mild and moderate non-proliferative diabetic retinopathy was assessed in terms of detection of retinopathy in images with mild and moderate non-proliferative diabetic retinopathy respectively. For each image, the optometrists were asked three multiple choice questions: (1) in your opinion, is this an eye with diabetic retinopathy? (2) what clinical findings gave the foundation for your assessment? and (3) based solely on retinal findings, how would you manage this patient if they were not under the care of an ophthalmologist? Question one had a forced choice answer of either yes or no. For questions two and three, multiple responses were possible. Possible answers for question two were: no retinopathy, microaneurysms, hard exudates, cotton wool spots, venous beading, intraretinal microvascular abnormalities (IRMA), neovascularisation, and other findings/ provisional diagnosis. Possible answers for question three were: none/routine follow-up, report to general practitioner (GP), referral to GP, and referral to ophthalmologist. The optometrists used their own computer with their ordinary screen for viewing. They could move back and forth in the VIMOC exam to review the images and to revise their prior assessments before admitting their response. In addition, the optometrists were to answer questions about which instruments they had available for retinal examination, their preferred method of retinal examination, their preferred method of retinal examination for patients with diabetes, which instruments they had available for retinal imaging, their work experience, their level of optometric education and qualification to use diagnostic drugs, and gender. The VIMOC examination was tested in a pilot study by

3 academic optometrists, resulting in no changes being made. Data were collected in February and March 2011 and one reminder was sent.

5.5 Data entry and verification

5.5.1 Papers I and II

The data were entered into the statistical program Statistical Package for the Social Sciences (SPSS) by the author. Two databases were generated, one for the questionnaire survey and one for the practice registration form study. One optometrist had completed the practice registration form incorrectly; this form was therefore excluded. All data entries were checked manually for discrepancies by an assistant. The error rate was less than 0.25 % in the original files. The errors were corrected and the corrected files were used for analysis.

5.5.2 Paper III

The data were entered into an Excel spread sheet by a professional data entry service (Bredesen Puncheservice as, Lørenskog). Data entries for 200 (14%) questionnaires were checked manually for discrepancies by an assistant. The error rate was less than 0.20 % in the original file. For statistical analyses, the Excel spread sheet was exported to SPSS.

5.5.3 Paper IV

The data were entered into an Excel spread sheet by the author and a co-worker. Data entries for 20 (14%) registration forms were checked manually for discrepancies by the co-worker. The error rate was less than 0.40% in the original file. For statistical analysis the Excel spread sheet was exported to SPSS.

5.5.4 Paper V

The data were collected using Question Writer 4. Data entry was made directly by the optometrist when submitting their responses in the web-based examination. The optometrists' responses were downloaded as a comma-separated value file. The database was then opened and arranged in Excel, and then exported to SPSS.

5.6 Data analysis

The original questionnaires, practice registration form, clinical examination registration form, image analysis form and VIMOC exam are provided in Appendices 1 to 7. The variables are defined in detail in the Variable list in Appendix 8. All statistical methods used were standard statistical methods. The data analysis was performed with the statistical package SPSS, version 12.0.2 -17.0. Specific variables and statistical methods used in Papers (I-V) are described below.

5.6.1. Main variables

Vision and eye examination

Eye examination was defined as an ocular examination including a retinal examination. Vision examination was defined as an examination of eyesight. Regular examination was defined as examination at regular intervals, e.g. yearly, every six months or monthly. In the questionnaire completed by patients with diabetes (Paper III and IV), the specific questions about eye examination were: "Do you have your eyes regularly examined due to your diabetes?", "In general, how long is it between the eye examinations?", "Do you have your vision regularly examined?", and "How long time is it between the vision examinations?".

Ocular disease

History of ocular disease was defined by patient-reported history of cataract, glaucoma, age related macular degeneration, and/or diabetic retinopathy (Papers I, II, III and IV). A clinical finding of ocular disease was defined by an optometrist's reported finding of cataract and/or any retinopathy (Papers I, II and IV) and an ophthalmologist's diagnosis of diabetic retinopathy (Paper IV).

Visual impairment

Visual impairment was defined as reduced functional vision, visual impairment, low vision, blindness and correctable visual impairment (Papers I and IV), as defined in 5.1.2.

Retinopathy

Retinopathy was defined as any disease abnormality affecting the retina identified by: (1) patient-reported history of retinopathy (Papers I, II, and III), (2) optometrist's finding of suspected retinopathy (Papers I and II) and (3) ophthalmologist's diagnosis of diabetic retinopathy (Papers IV and V). The classifications of retinopathy and diabetic retinopathy are given in 5.1.3 and Table 3.2.

Diagnostic sensitivity and specificity

Diagnostic sensitivity and specificity of diabetic retinopathy were estimated based on the practice registration form findings and calculated from the results of the VIMOC examination. The screening standard was defined according to the screening standard established by the British Diabetic Association (Diabetes UK) [138] of at least 80% sensitivity and 95% specificity.

Patient management

Patient management in optometric practice was defined as subsequent handling of the patients seen for full eye examination (Papers I and II) and subsequent patient management based on retinal image evaluation (Paper V). Patient management was divided into: (1) no further action/routine optometric follow-up, (2) patient requested to contact GP and/or ophthalmologist (not defined in Paper V), (3) report to GP and/or ophthalmologist, and (4) referral to GP and/or ophthalmologist.

Collaboration in optometric practice

Collaboration in optometric practice was defined as an interaction between the optometrist and GP and/or ophthalmologist. Collaboration was divided into: (1) telephone referral/consultation, (2) remitting reports and/or referrals, (3) receiving reports and/or referrals, and (4) joint practice.

5.6.2 Statistical methods Papers I and II

In Papers I and II, the data were analysed in frequency and summation tables. Differences between proportions were analysed using chi-square tests. A p-value < 0.05 was considered statistically significant. Variables associated with retinopathy were analysed using bivariate and multivariate logistic regression analysis. Variables with $p \leq 0.25$ from the bivariate analyses were entered into the logistic regression models. A list of optometrists registered in Norway at the time of the study was obtained for analysis of gender, age and health region of practice for the non-respondents.

5.6.3 Statistical methods Paper III

Questionnaires with missing data for gender, age or type of diabetes, or diabetes other than type 1 and type 2 (3 %) were excluded from analysis. The data were analysed in frequency and summation tables. Group differences were analysed using the Student's-*t*,

chi-square and Fisher's exact tests. Due to the large size of the data, a p-value < 0.01 was considered statistically significant. Variables associated with a known history of diabetic retinopathy, visual symptoms, regular follow-up and lack of eye examination were analysed using bivariate and multiple logistic regression. Variables with p≤ 0.25 from the bivariate analyses were entered into the logistic regression models. In addition to prevalence odds ratios (PORs), prevalence ratios (PRs) were calculated for variables associated with a history of diabetic retinopathy and regular eye examination. The POR estimates the incidence rate ratio (risk factors/predictors) with fewer assumptions than the PR [157]. However, the PR is considered by many to be easier to interpret, and is a better measure of public health burden of a disease [157].

5.6.4 Statistical methods Paper IV

In Paper IV, data were analysed using standard parametric and non-parametric statistical methods. The inter-grader agreement for the retinal photographs was measured by Cohen's kappa coefficient (κ); a κ-value >0.60 was considered to represent substantial inter-grader agreement and a κ-value >0.80 was considered to represent almost perfect agreement [158]. Group differences in presenting VA, BCVA, visual impairment and prevalence of retinopathy were analysed at an individual level using the two-tailed independent Student's *t*-test and the Pearson Chi-square test. The 95% confidence interval for prevalence was calculated by an exact method because of the small sample sizes. Vision and eye examination were analysed by Pearson's chi-square test. The general relationship between VA and other variables was analysed for the right eye by rank correlation tests, Spearman's rho and Kendall's tau. A p-value < 0.05 was considered statistically significant. Predictors of retinopathy were analysed by bivariate and multivariate logistic regression. Baseline risk factor variables with missing data for more than 20% of the participants were excluded from analysis. Variables with p-values ≤ 0.25 from the bivariate analyses were entered into the logistic regression model.

5.6.5 Statistical method Paper V

In Paper V, the data were analysed in frequency and summation tables; group differences were analysed by chi-square tests. Diagnostic sensitivity and specificity with 95% confidence intervals were calculated for any retinopathy, and for mild and moderate non-proliferative retinopathy. Associations between diagnostic quality and formal education were analysed using the Pearson Chi-square and Student's-*t* tests. A p-value ≤0.05 was regarded as significant.

5.7 Formal approvals and ethics

All parts of this study followed the tenets of the Declaration of Helsinki for research involving humans. The studies in Papers I and II were presented to the REK. The studies were not regarded subject to specific evaluation and approval. The Norwegian Social Science Data Services were notified before study commencement. Information about the study, the voluntary nature of participation and confidentiality was provided in the invitation sent to the optometrists. A notice was posted in each participating consulting room/practice notifying patients of the on-going practice registration form study. Patient data were anonymised before being passed to the research team and the responding optometrists were anonymous to the researchers. The study in Paper III was approved (May 12. 2005) by the REK. Data were collected anonymously. Information about the study, the voluntary nature of participation, confidentiality and study approval was given on the front page of the questionnaire. The return of a completed questionnaire was regarded as written consent. In Paper IV, the questionnaire was approved (May 12. 2005) by the REK. Information about the study, the voluntary nature of participation and confidentiality was provided in the invitation, along with an informed consent form (Appendix 8). The REK approved (January 19. 2009) the planned analyses of the data from the clinical study and baseline information from the HUNT 2 -study. Patient data

were anonymised before statistical analysis. The study in Paper V was not regarded subject to evaluation and approval by the REK.

6. Results

6.1 Response rate

In Papers I and II, 508 (64%) optometrists responded to the questionnaire survey, of these 212 (42%) completed the practice registration form, reporting 4,052 patient encounters. In Paper III, 1,396 (74%) of the invited members of the NDA, responded to the questionnaire survey. Forty-four of the completed questionnaires had missing information regarding, for age, gender, or type of diabetes; in some cases, the respondent had diabetes other than type 1 or type 2. Questionnaire analysis was based on the remaining 1,352 cases. In Paper IV, 126 of the 163 (77%) invited people participated in the clinical examination: 20 (83%) of the patients with known diabetes, 36 (68%) of the patients with screen-detected diabetes, 38 (83%) of the people with impaired glucose tolerance and 32 (74%) of the people with normal glucose tolerance. In Paper V, 112 (11%) optometrists agreed to participate in the study; of these, 101 (90%) met the inclusion criteria and 74 (73%) completed the VIMOC examination.

6.2 Optometric practice

6.2.1 Optometrists

The characteristics of the optometrists who either responded or did not respond to the questionnaire (2005, Papers I and II), the participating and non-participating optometrists in the practice registration form study (2005, Papers I and II), and the participating and non-participating optometrists in the VIMOC examination (2011, Paper V) are shown in Table 6.1. In 2005, participating optometrists reported that they performed, on average, 21 routine optometric examinations per week (standard deviation [SD] ± 11, range 0-70). However, the reported total number of patient examinations (including contact lens fittings and follow-ups) was, on average, 40 per week (SD ± 19, range 0-150).

Table 6.1 Characteristics of optometrists participating in the questionnaire survey, practice registration study, and VIMOC examination, and their reported routine and preferred method for retinal examination, Papers I, II and V

	Papers I and II (2004)								Paper V (2011)				
	Practice registration form (n=508)				Questionnaire (n=790)				VIMOC examination (n=1,028)				
Optometrist characteristics	Participants (n = 212)		Non-participants (n = 296)		Respondents (n = 508)		Non-respondents (n = 282)		Eligible sample NOF 2004 (n=761)		Participants (n=74)		Non-participants (n=954)		Eligible sample NOF 2011 (n=1,028)	
Gender n (%)																
Male	90	(43)	149	(51)	239	(47)	184	(66)	410	(54)	31	(42)	441	(46)	472	(46)
Female	120	(57)	146	(50)	266	(53)	96	(34)	346	(46)	43	(58)	513	(54)	556	(54)
Practice by national health region n (%)																
East	73	(35)	97	(33)	170	(34)	104	(37)	261	(34)	21	(28)	317	(33)	338	(33)
South	51	(24)	66	(23)	117	(23)	60	(21)	171	(23)	20	(27)	276	(29)	293	(29)
West	44	(21)	62	(21)	106	(21)	54	(19)	156	(21)	11	(15)	165	(17)	176	(17)
Middle	15	(7)	46	(16)	61	(12)	35	(13)	94	(12)	16	(22)	119	(12)	135	(13)
North	27	(13)	22	(8)	49	(10)	27	(10)	76	(10)	6	(8)	77	(8)	83	(8)
Higher education and special training n (%)																
Master of Science in optometry	44	(21)	50	(17)	94	(19)			92	(12)	22	(30)	133	(14)	196	(19)
Right to employ diagnostic drugs	50	(24)	53	(18)	103	(20)			101	(13)	63	(85)	520	(55)	583	(57)
Number of years in optometric practice n (%)																
≤ 5 years	75	(36)	77	(26)	152	(30)					21	(28)				
6-10 years	47	(22)	62	(21)	109	(22)					17	(23)				
11-20 years	54	(26)	94	(32)	148	(30)					27	(36)				
≥ 21	34	(16)	60	(21)	94	(19)					9	(12)				
Ophthalmoscopy part of routine exam n (%)	201	(96)	266	(90)	467	(92)										
Method of retinal examination n (%)																
Direct ophthalmoscopy	116	(56)	175	(61)	291	(59)					9	(12)				
Indirect ophthalmoscopy	54	(26)	44	(15)	98	(20)					35	(47)				
Both direct and indirect ophthalmoscopy	21	(10)	23	(8)	44	(9)										
Retinal fundus photography	1	(0.5)	7	(2)	8	(2)					25	(34)				

Optometrists who held an MSc in clinical optometry examined the retina more frequently during their routine examinations than those with a basic optometric education (94% versus 87%, p<0.001) and more frequently performed dilated retinal examinations (5% versus 1%, p<0.001). Furthermore, they reported detecting a higher prevalence of retinopathy than optometrists with a basic optometric education (8% versus 3%, p<0.001).

6.2.2 Patients examined in optometric practice

The mean (SD) number of patients encountered by each optometrist in the practice registration form was 19 (±3), the range was 2 to 20 patients. In total, 4,052 patient encounters were recorded (Table 6.2). The majority of patients were 35 years or older. In all, 24% of the patients were known to have ocular disease or systemic disease of ocular relevance, and 12% had known ocular disease. Two percent of patients were visually impaired (BCVA<0.5), of these more than half had low vision (BCVA < 0.33). In general, VA was poorer among the elderly (Figure 6.1).

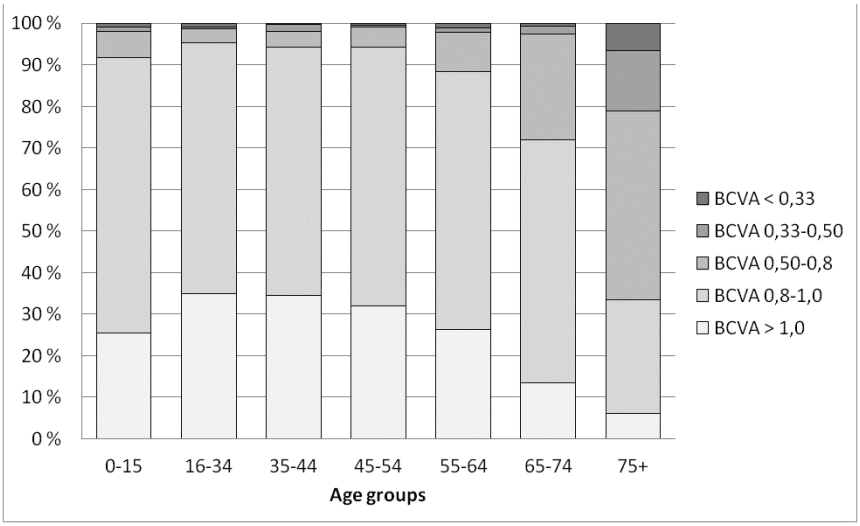


Figure 6.1 Best corrected visual acuity of the patients (n=4,025) examined in optometric practice during the practice registration form study in 2004-2005 (Paper I)

Table 6.2 Characteristics of patients examined in optometric practice during the practice registration study in 2004-2005, Papers I and II

	Patients examined by optometrists							
	All groups	**0-15 years**	**16-34 years**	**35-44 years**	**45-54 years**	**55-64 years**	**65-74 years**	**≥ 75 years**
Age distribution[a] n (%)	4,041 (99.7)	326 (8.1)	792 (19.6)	543 (13.4)	874 (21.6)	661 (16.4)	426 (10.5)	419 (10.4)
Gender distribution[b] n (%)								
Male	1,699 (43.3)	150 (47.6)	307 (40.1)	222 (42.2)	382 (45.3)	283 (44.1)	179 (43.9)	170 (41.5)
Female	2,216 (56.7)	165 (52.3)	457 (59.8)	304 (57.8)	461 (54.7)	356 (55.7)	229 (56.1)	240 (58.5)
Ocular and medical history n (%)								
Cataract	371 (9.2)	1 (0.3)	8 (1.0)	7 (1.3)	26 (3.0)	46 (7.0)	91 (21.4)	188 (44.9)
Glaucoma	109 (2.7)	0 (0.0)	1 (0.1)	6 (1.1)	22 (2.5)	19 (2.9)	25 (5.9)	36 (8.6)
Age related macular degeneration	99 (2.4)	0 (0.0)	1 (0.1)	1 (0.2)	3 (0.3)	11 (1.7)	18 (4.2)	63 (15.0)
Hypertension	439 (10.8)	0 (0.0)	6 (0.8)	17 (3.1)	65 (7.4)	123 (18.6)	113 (26.5)	110 (26.3)
Cardio-vascular disease	238 (5.9)	2 (0.6)	4 (0.5)	5 (0.9)	15 (1.7)	44 (6.7)	63 (14.8)	105 (25.1)
Diabetes	166 (4.1)	4 (1.2)	16 (2.0)	16 (2.9)	22 (2.5)	39 (5.9)	34 (8.0)	35 (8.4)
Family history of diabetes	302 (7.5)	20 (6.1)	42 (5.3)	41 (7.6)	74 (8.5)	63 (9.5)	36 (8.5)	25 (6.0)
Visual impairment n (%)								
Visually impaired (BCVA[c] < 0.5)	99 (2.4)	3 (0.9)	9 (1.2)	3 (0.6)	8 (0.9)	11 (1.7)	7 (1.7)	57 (13.7)
Low vision (BCVA[c] < 0.33)	54 (1.3)	3 (0.9)	6 (0.8)	1 (0.2)	5 (0.5)	8 (1.2)	3 (0.7)	28 (6.7)
Blind (BCVA[c] <0.05)	4 (0.1)	0 (0.0)	2 (0.3)	0 (0.0)	2 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
Retinal examination	3576 (88.3)	245 (75.2)	600 (75.8)	486 (86.2)	819 (93.7)	630 (95.3)	406 (95.3)	398 (95.0)
Dilated retinal examination[d]	78 (2.2)	7 (2.9)	3 (0.5)	6 (1.3)	21 (2.6)	13 (2.1)	8 (2.0)	20 (5.0)
Clinical findings of ocular disease n (%)								
Cataract	442 (10.9)	1 (0.3)	4 (0.5)	3 (0.6)	24 (2.7)	70 (10.6)	119 (27.9)	218 (52.0)
Retinopathy[e]	116 (3.2)	0 (0.0)	2 (0.3)	3 (0.6)	13 (1.6)	20 (3.2)	22 (5.4)	56 (14.0)
Macular disease	56 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.5)	3 (0.5)	12 (3.0)	37 (9.3)
Hypertensive/vascular retinopathy	27 (0.8)	0 (0.0)	1 (0.2)	0 (0.0)	6 (0.7)	9 (1.4)	5 (1.2)	6 (1.5)
Diabetic retinopathy	23 (0.6)	0 (0.0)	1 (0.2)	3 (0.6)	2 (0.2)	4 (0.6)	4 (1.0)	9 (2.3)
No tentative diagnosis	10 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)	4 (0.6)	1 (0.2)	4 (1.0)
Referred for medical assessment	258 (6.4)	8 (2.5)	20 (2.5)	13 (2.4)	33 (3.8)	40 (6.1)	54 (12.7)	86 (20.6)

BCVA, best corrected visual acuity.
Data missing for [a]11, [b]137, [c]45, [d]10 and [e]488 patients

In total, 166 (4%) patients had a known history of diabetes, of whom 61 (37%) had some known ocular disease, 34 (20%) had a known history of hypertension, and 14 (8%) had a known history of cardiovascular disease other than hypertension.

History of retinopathy, findings of cataract, age greater than 75 years, and female gender were all associated with reduced functional visual acuity. The BCVA was poorer among patients with diabetes than those without (Figure 6.2a and Figure 6.2b).

In all, 11% of patients were considered to be in need of further medical attention. A referral or report to a GP or ophthalmologist was sent in 6% and 3% of patient encounters, respectively. Another 2% of patients were orally requested to contact their GP (Table 6.3).

Figure 6.2 Best corrected visual acuity of patients with and without diabetes examined in optometric practice during the practice registration study in 2004-2005, Paper I

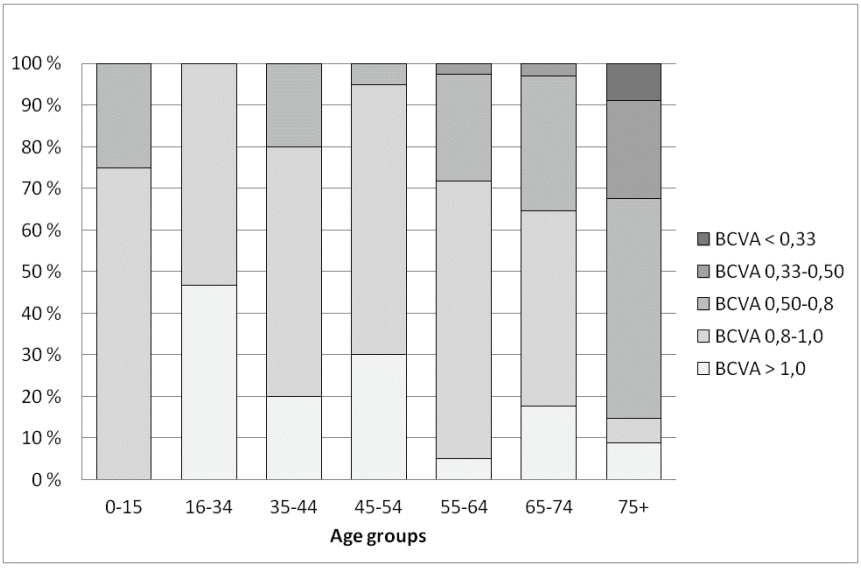


Figure 6.2a Best corrected visual acuity (BCVA) for patients with diabetes (n=166)

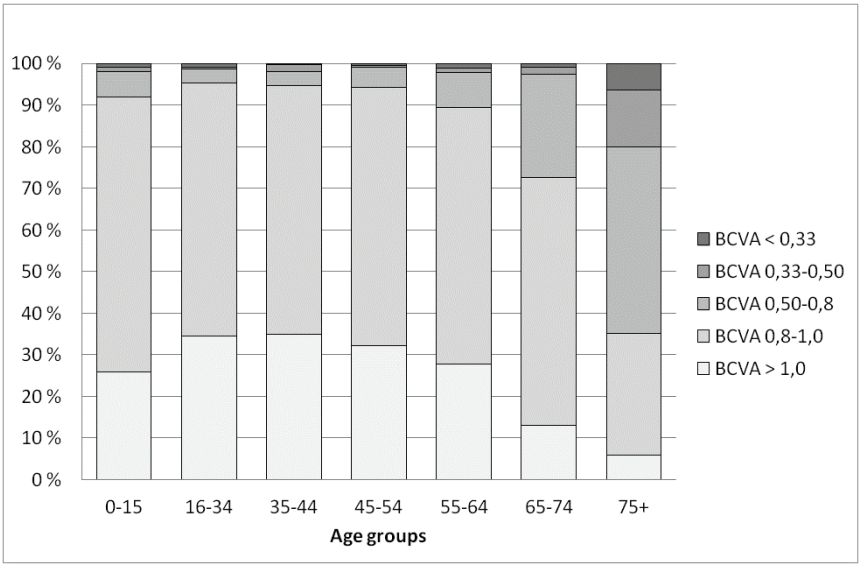


Figure 6.2b Best corrected visual acuity (BCVA) for patients without diabetes (n=3886)

Table 6.3 Management of patients with ocular findings detected by routine eye examination in Norwegian optometric practice during the practice registration study in 2004-2005, Papers I and II

Clinical findings in patients examined	All (N=4,052)	Referral sent (n=258)	Report sent (n=113)	Patient contacts GP (n=88)	No / Routine follow-up (n=3,593)
Ophthalmoscopy part of the examination n (%)	**3,576**	**251(7.0)**	**105 (2.9)**	**83 (2.3)**	**3,137 (87.7)**
Retinopathy	116	31 (26.7)	16 (13.7)	11 (9.5)	58 (50.0)
Macular disease	56	16 (28.6)	7 (12.5)	3 (5.3)	30 (53.6)
No known history of retinopathy	31	14 (45.2)	2 (6.5)	2 (6.5)	13 (41.9)
Known history of retinopathy	25	2 (8.0)	5 (20.0)	1 (4.0)	17 (68.0)
Hypertensive/vascular retinopathy	27	7 (25.9)	7 (25.9)	2 (7.4)	11 (40.7)
No known history of retinopathy	26	7 (25.9)	6 (23.1)	2 (7.7)	11 (42.3)
Known history of retinopathy	1	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
Diabetic retinopathy	23	5 (21.7)	2 (7.4)	5 (21.7)	11 (47.8)
No known history of retinopathy	14	5 (35.7)	1 (7.1)	2 (14.3)	6 (42.9)
Known history of retinopathy	9	0 (0.0)	1 (11.1)	3 (33.3)	5 (55.6)
Tentative diagnosis not stated	10	3 (30.0)	0 (0.0)	1 (10.0)	6 (60.0)
Cataract [a]	426	112 (26.3)	38 (8.9)	24 (9.8)	252 (59.2)
No known history of cataract	197	53 (26.9)	15 (7.6)	9 (4.6)	120 (61.0)
Known history of cataract	229	59 (25.8)	23 (10.0)	15 (6.6)	132 (57.6)
Glaucoma	16	11 (68.8)	1 (6.3)	0 (0.0)	4 (25.0)
No known history of glaucoma	10	9 (90.0)	1(10.0)	0 (0.0)	0 (0.0)
Known history of glaucoma	6	2 (33.3)	0 (0.0)	0 (0.0)	4 (66.7)
Other ocular disease	46	13 (28.3)	1 (2.2)	1 (2.2)	31 (67.4)
No ocular findings / ocular findings not reported	3,028	103 (3.4)	56 (1.8)	50 (1.7)	2,819 (93.41)
Ophthalmoscopy not part of the examination n	**476**	**7 (1.5)**	**8 (1.7)**	**5 (1.1)**	**456 (95.8)**
Cataract[b]	16	2 (12.5)	0 (0.0)	0 (0.0)	14 (87.5)
No known history of cataract	8	1 (12.5)	0 (0.0)	0 (0.0)	7 (87.5)
Known history of cataract	8	1 (12.5)	0 (0.0)	0 (0.0)	7 (87.5)
Other ocular disease	5	0 (0.0)	1 (20.0)	0 (0.0)	4 (80.0)
No ocular findings / ocular findings not reported	456	5 (1.1)	7 (1.5)	5 (1.1)	439 (96.3)

GP, General Practitioner. Additional clinical findings of retinopathy, glaucoma or other ocular disease were found in [a]56 and [b]1 patient(s) with findings of cataract

6.3 Patients with diabetes

This thesis includes information from three different samples of patients with known diabetes (n=1,538) (Table 6.4). Patients from the HUNT sample (Paper IV) were older than either the patients seen in optometric practice (Paper I and II) or the NDA members (Paper III). There were no significant differences between the groups with respect to the reported type of diabetes, self-reported history of diabetic retinopathy, laser-treated diabetes-related ocular disease, cataract or age-related macular degeneration. The reported frequency of a known history of glaucoma was significantly higher for members of the NDA than for the other two groups.

In the practice registration study (Paper I and II), 34 (20%) of the 166 patients with a self-reported history of diabetes had reduced functional vision (BCVA<0.8) and nine (5%) were visually impaired (BCVA ≤0.5), of which four had low vision (BCVA < 0.33). In the clinical study (Paper V) none of the participants with known or screen-detected diabetes were visually impaired (BCVA<0.5), but 2 (4%) had reduced functional vision and 2(4%) had a correctable visual impairment.

Table 6.4 Characteristics of patients with known diabetes: members of the Norwegian Diabetes Association responding to the questionnaire (2005), patients examined in optometric practice during the practice registration study (2004-2005), and patients from the HUNT sample taking part in the clinical examination study (2005), Papers I-IV

	Norwegian Diabetes Association (n=1,352)		Norwegian optometric practice (n=166)		The HUNT study (n=20)	
Gender n (%) (n=1,352/157/20)						
Female	699	(51.7)	83	(52.9)	9	(45.0)
Male	653	(48.3)	74	(47.1)	11	(55.0)
Age distribution n (%) (n=1,352/166/20)***						
0-15			4	(2.4)		
16-34	100	(7.4)	16	(9.6)	0	(0.0)
35-44	130	(9.6)	16	(9.6)	1	(5.0)
45-54	216	(16.0)	22	(13.3)	0	(0.0)
55-64	397	(29.4)	39	(23.5)	9	(45.0)
65-74	301	(22.3)	34	(20.5)	8	(40.0)
75+	208	(15.4)	35	(21.5)	2	(10.0)
Duration of diabetes mean (SD) (n=1,321/126/12)	14	(±12)	9	(±11)	11	(±15)
Type of diabetes n (%) (n=1,352/128/19)						
Type 1	451	(33.4)	32	(25.0)	2	(10.5)
Type 2	901	(66.6)	94	(73.4)	17	(89.5)
Other			2	(1.6)	0	(0.0)
Regular vision examination n (%) (n=1,336/18)	1,161	(85.9)			13	(68.4)
Regular eye examination n (%) (n=1,336/20)	1,141	(85.4)			16	(80.0)
Known history of ocular disease n (%)						
Cataract (n=1,019/166/20)	261	(25.6)	34	(20.5)	6	(30.0)
Diabetic retinopathy (n=1,058/131/20)	182	(17.2)	18	(13.7)	1	(5.0)
Glaucoma (n=905/166/20)*	93	(10.3)	6	(3.6)	1	(5.0)
Age-related macular degeneration (n=857/166/20)	35	(4.1)	3	(1.8)	0	(0.0)
Laser treated diabetic ocular disease n (%) (n=1,052/128/18)	124	(11.8)	13	(10.2)	1	(5.6)
History of diabetic retinopathy reported	105	(10.0)	11	(8.6)	0	(0.0)
History of diabetic retinopathy not reported	19	(1.8)	2	(1.6)	1	(5.6)
Informed about importance of eye examination n (%)	1,169	(86.8)			15	(75.0)
Source of information (not mutually exclusive) n (%)						
General practitioner	678	(50.3)			12	(80.0)
Ophthalmologist	515	(38.2)			5	(33.3)
Hospital	338	(25.1)			3	(20.0)
Other medical practitioner	114	(8.5)			2	(13.3)
Optometrist	93	(6.9)			1	(6.7)
Leaflets/Journal of the Norwegian Diabetes Association	298	(22.1)			1	(6.7)
Diabetes patient education course	218	(16.2)			2	(13.3)
Media	68	(5.0)			1	(6.7)
Other patients with diabetes	94	(7.0)			0	(0.0)

*p< 0.05 Fisher's exact test
***p<0.001 Pearson chi-square

6.4 Paper I

In the questionnaire, all optometrists (n=508) reported that taking a patient history of vision and ocular health was part of their routine consultation. Fifty-five percent of optometrists established the general health history of all patients, and 42% established diabetes history in particular. Refraction was always part of the routine examination, and the majority of optometrists performed ophthalmoscopy, binocular examination and tonometry as part of their routine examination. Less than half reported including slit lamp examination of the anterior segment and visual field examination in their routine examinations. Optometrists (n=212) who completed the practice registration form reported more frequently that they included ophthalmoscopy as part of their routine examination than non-participating optometrists, that is, the optometrists who completed the questionnaire, but not the practice registration form (96% versus 90%, $p<0.01$), and graded their fundus evaluation skills more highly. More than 80% of optometrists reported collaborating with GPs and ophthalmologists. Written reports were more frequently sent to GPs than to ophthalmologists (48% versus 39%, $p<0.01$), as were referrals (83% versus 66%, $p<0.001$), whereas telephone contact/referral was more commonly made to ophthalmologists than to GPs (54% versus 20%, $p<0.001$). Patient reports were more often received from ophthalmologists than from GPs (65% versus 24%, $p<0.001$). Optometrists participating in the practice registration study reported more frequently that they: (1) sent reports to GPs (55% versus 44%, $p<0.05$) and received referrals from GPs (30% vs. 22%, $p<0.05$) GPs, and (2) received patient reports from ophthalmologists (68% versus 56%, $p<0.01$) than the non-participating optometrists. Clinical findings of cataract and retinopathy were reported in, respectively 11% and 3% of the patients examined (n=4,052). In all, 6% of patients were referred. In half of the referrals, the receiver of the referral was accounted for; 72% of these referrals were made to a GP, 25% to an ophthalmologist and 3% to a casualty department.

6.5 Paper II

The majority of optometrists (96%) participating in the practice registration study (n=212) reported performing ophthalmoscopy as part of their routine examination; 24% were qualified to undertake dilated retinal examination. Direct ophthalmoscopy was the most frequently used method of retinal examination; it was reported as preferred method of examination by 59% of optometrists (Table 6.1). Ophthalmoscopy was performed in 3,576 out of 4,052 (88%) patient encounters; of these, 78 (2%) were dilated retinal examinations. Ophthalmoscopy was performed significantly more often in the 166 patients with known diabetes (in 96% of examinations), than in the 3,886 patients without diabetes (in 88% of examinations). A tentative diagnosis of retinopathy was made for 106 (3%) patients, of whom two thirds had no previous history of retinopathy (Table 6.2). Diabetic retinopathy was suspected in 23 patients, of whom 14 had no history of retinopathy and 6 had no history of diabetes. In patients with suspected hypertensive/vascular retinopathy, 10 out of 27 had no history of hypertension and/or cardiovascular disease, and none had a known history of diabetes.

Diabetic retinopathy was detected in 17 out of 159 (11%) of patients with diabetes, 9 of whom had a reported history of diabetic retinopathy. In 9 of the 18 patients (50%) with a reported history of diabetic retinopathy, the retinopathy was not detected by the optometrist. Seven of these patients had undergone laser treatment. In 9 of the 18 patients (50%) with a reported history of diabetic retinopathy, the retinopathy was not detected by the optometrist. Seven of these patients had undergone had undergone laser treatment. Multivariate logistic regression analysis showed that old age (75 years or older), hypertension and diabetes were independent predictors for any retinopathy, with odds ratios (ORs) (95% CI) of 6.4 (4.2 to 9.9), 3.8 (2.4 to 6.0) and 2.5 (1.4 to 4.7), respectively. For vascular retinopathy, only diabetes and hypertension were independent predictors, with ORs (95% CI) of 7.2 (3.7 to 14.1) and 4.9 (2.6 to 9.3), respectively. In total, the optometrists judged 439 of the 3,576

(12%) retinally-examined patients to be in need of some medical follow-up of ocular findings. Among the 106 patients with suspected retinopathies, 54 (51%) were considered to be in need of some further management (Table 6.3). Patients with retinopathy were significantly ($p<0.01$) more frequently urged to see a physician if the retinopathy was previously unknown (41 out of 71 patients) than if it was known (13 out of 35 patients).

6.6 Paper III

In all, 1,141 (85%) of the NDA questionnaire respondents reported to have regular eye examinations. Of these, 1,052 (92%) were examined according to the recommended follow-up schedule. Only 6% reported never having had their eyes examined. The initial examination was in accordance with guidelines in 31% of respondents with type 1 diabetes, and in 47% of respondents with type 2 diabetes. The median interval between eye examinations was 12 months; this accounted for 65% of respondents, 18% were examined more frequently. In patients with type 1 diabetes, 88% (358/407) were examined annually or more frequently, with a follow-up interval of: 1 to 3 months in 2%, 4 to 6 months in 15%, 7 to 9 months in 3%, and 10 to 12 months in 69%. In patients with type 2 diabetes, 98% (694/711) were examined biannually or more frequently, with a follow-up interval of: 1 to 3 months in 2%, 4 to 6 months in 13%, 7 to 9 months in 1%, 10 to 12 months in 63%, and 12 to 24 months in 18%. In all, 1,169 (87%) respondents confirmed that they had received information about the importance of having regular eye examinations because of their diabetes. Respondents who had their eyes examined according to the guidelines were more likely to have received such information than respondents who did not have regular eye examinations (95% versus 42%, $p<0.001$). The factors of having received information about the importance of eye examinations, and diabetes duration of more than 10 years, were both independently associated with the performance of regular eye examinations. Spectacles and/or contact lenses were used by 1,188 (88%) of the respondents. Patients who used optical correction were more likely to have their vision regularly examined than respondents

who did not use optical correction (88% versus 71%, p<0.001). Visual problems related to diabetes were reported by 156 (12%) respondents. Among patients who reported visual problems and who also had a known history of diabetic retinopathy, 81% reported a history of laser treatment for ocular disease related to diabetes. In total, 178 (13%) respondents reported a history of diabetic retinopathy, of whom 101 (57%) also had a history of laser treatment. A reported history of diabetic retinopathy was more frequent in patients with a diabetes duration of more than ten years than in patients with shorter disease duration; the prevalence ratio (95% CI) was 3.5 (2.5 to 5). A history of diabetic retinopathy was more frequently reported by respondents who had their eyes regularly examined than by respondents who did not undergo regular eye examinations (19% versus 5%). A reported history of diabetic retinopathy was associated with type 2 diabetes, a diabetes duration of more than 10 years, use of oral anti-diabetic agents, use of insulin, HbA_{1c} levels above 7%, unstable blood glucose levels and the use of anti-hypertensive medication. In a multivariate logistic regression analysis, diabetes duration was the only variable that was independently associated with a history of diabetic retinopathy.

6.7 Paper IV

In total, 126 people from the HUNT population underwent clinical examination; 20 of these had known diabetes (Table 6.5). In all, 23 [18%, 95%CI (12, 26)] had a known history of one or more ocular disease. The reported history of cataract was significantly higher among participants with diabetes or screen-detected diabetes, than among people with impaired glucose tolerance or normal glucose tolerance. Previously undiagnosed ocular disease was found in 25% [95% CI (18, 33)] of people. Retinopathy consistent with diabetic retinopathy was present in seven participants [6%, 95% CI (3, 13)], two of whom had a known history of diabetes. Six people [6%, 95% CI (2, 12)] had mild non-proliferative retinopathy and one [1%, 95% CI (0, 5)] had moderate non-proliferative diabetic retinopathy. Neither a known history of diabetes, nor current glycaemic status, was associated with findings of retinopathy.

There was no significant difference in baseline body mass index, hip-waist-ratio, non-fasting plasma blood glucose, cholesterol, high density lipoprotein (HDL)-cholesterol or blood pressure, between people with and without diabetic retinopathy. In a multivariate logistic regression analysis, non-fasting plasma glucose levels 10 years previously was an independent risk factor for developing retinopathy [OR 1.5, 95% CI (1.01, 2.13), p=0.046]. In total, 108 participants [86%, 95% CI (79, 91)] used optical correction. Of all the participants, 19 [15%, 95%CI (9, 23)] had reduced functional vision (VA < 0.8) with their presenting correction and 4 [3%, 95%CI (1, 8)] were visually impaired (VA < 0.5). With the best optical correction, 3 [2%, 95%CI (1, 7)] people had reduced functional vision (BCVA < 0.8), but none were visually impaired (Figure 6.3). In bivariate analyses of BCVA, VA was negatively correlated with increasing age and findings of cataract. Correctable visual impairment [3%, 95%CI (1, 8)] was associated with old age, but not with hyperglycaemic category group, gender, history of ocular disease, history of diabetes, regular vision examination or regular eye examination.

Table 6.5 Characteristics of the sample from the HUNT population examined in the clinical examination study (2005), Paper IV

	All (n=126)			KDM (n=20)			SDM (n=36)			IGT (n=38)			NGT (n=32)		
	n	(%/SD)	[95%CI]	N	(%/SD)	[95%CI]	n	(%/SD)	[95%CI]	n	(%/SD)	[95%CI]	N	(%/SD)	[95%CI]
Gender															
Female	69	(55)	[46, 64]	7	(35)	[15, 60]	20	(56)	[38, 72]	24	(63)	[46, 78]	18	(56)	[38, 74]
Male	57	(45)	[36, 54]	13	(65)	[41, 85]	16	(44)	[28, 62]	14	(37)	[22, 54]	14	(44)	[26, 62]
Mean age	59	(±14)		64	(±8)		62	(±15)		57	(±15)		56	(±13)	
Eye care and optical correction															
Regular vision examination**[a]	42	(34)	[26, 43]	13	68	[43, 87]	10	29	[15, 46]	11	29	[15, 46]	8	25	[12, 43]
Regular eye examination**	39	(31)	[23, 40]	16	80	[56, 94]	9	25	[12, 42]	7	18	[7, 34]	7	22	[9, 40]
Use of optical correction	108	(86)	[78, 91]	17	85	[62, 97]	32	89	[74, 97]	31	81	[66, 92]	28	87	[71, 96]
Known history of ocular disease															
Cataract**	14	(11)	[6, 18]	6	(30)	[12, 54]	6	(17)	[6, 33]	2	(5)	[1, 18]	0	(0)	[0, 11]
Diabetic retinopathy	1	(1)	[0, 4]	1	(5)	[0, 25]	0	(0)	[0, 10]	0	(0)	[0, 9]	0	(0)	[0, 11]
Glaucoma	5	(4)	[1, 9]	1	(5)	[0, 25]	1	(3)	[0, 15]	2	(5)	[1, 18]	1	(3)	[0, 16]
Age-related macular degeneration	1	(1)	[0, 4]	0	(0)	[0, 25]	1	(3)	[0, 15]	0	(0)	[0, 9]	0	(0)	[0, 11]
Hypertensive retinopathy	1	(1)	[0, 4]	0	(0)	[0, 25]	0	(0)	[0, 10]	1	(3)	[0, 14]	0	(0)	[0, 11]
Other ocular disease	5	(4)	[1, 9]	0	(0)	[0, 25]	1	(3)	[0, 15]	3	(8)	[2, 21]	1	(3)	[0, 16]
Experience of visual symptoms															
Floaters	42	(33)	[5, 42]	5	(25)	[9, 50]	12	(33)	[19, 51]	14	(37)	[22, 54]	11	(34)	[19, 53]
Blur	29	(23)	[16, 31]	5	(0)	[0, 25]	7	(19)	[8, 36]	9	(24)	[11, 40]	8	(25)	[12, 43]
Photophobia	19	(15)	[9, 23]	2	(10)	[1, 32]	2	(6)	[1, 19]	7	(18)	[8, 34]	8	(25)	[12, 43]
Variable vision	15	(12)	[7, 19]	1	(5)	[0, 25]	4	(11)	[3, 26]	3	(8)	[2, 21]	7	(22)	[9, 40]
Visual field loss	13	(10)	[6, 17]	0	(0)	[0, 25]	3	(8)	[2, 22]	6	(16)	[6, 31]	4	(13)	[4, 29]
Diplopia	11	(9)	[4, 15]	2	(10)	[1, 32]	1	(3)	[0, 15]	4	(11)	[3, 25]	4	(13)	[4, 29]
Metamorphopsia	5	(4)	[1, 9]	0	(0)	[0, 25]	1	(3)	[0, 15]	2	(5)	[1, 18]	2	(6)	[1, 21]
Clinical findings of ocular disease															
Cataract / PCO [b]	32	(26)	[19, 35]	4	(21)	[6, 46]	11	(31)	[16, 48]	10	(28)	[14, 45]	7	(23)	[10, 41]
Retinopathy according to DRDSS [c]	7	(6)	[3, 13]	2	(11)	[1, 35]	1	(4)	[1, 18]	1	(3)	[7, 15]	3	(10)	[2, 27]
Mild non-proliferative	6	(6)	[2, 12]	1	(6)	[0, 27]	1	(4)	[1, 18]	1	(3)	[7, 15]	3	(10)	[2, 27]
Moderate non-proliferative	1	(1)	[0, 5]	1	(6)	[0, 27]	0	(0)	[0, 12]	0	(0)	[0, 10]	0	(0)	[0, 12]

DRDSS, Diabetic Retinopathy Disease Severity Scale; IGT, impaired glucose tolerance; KDM, known diabetes mellitus; NGT, normal glucose tolerance; PCO, posterior capsular opacification; SDM, screen-detected diabetes. Data missing for [a] 2 participants, 1 KDM and 1 SDM, [b] 4 participants: 1 KDM, 2 IGT and 1 NGT and [c] 17 participants: 1 KDM, 8 SDM, 4 IGT and 1 NGT.
** $p<0.01$ Pearson chi-square test

Figure 6.3 Visual acuity of the sample from the HUNT population examined in the clinical study (2005), Paper IV

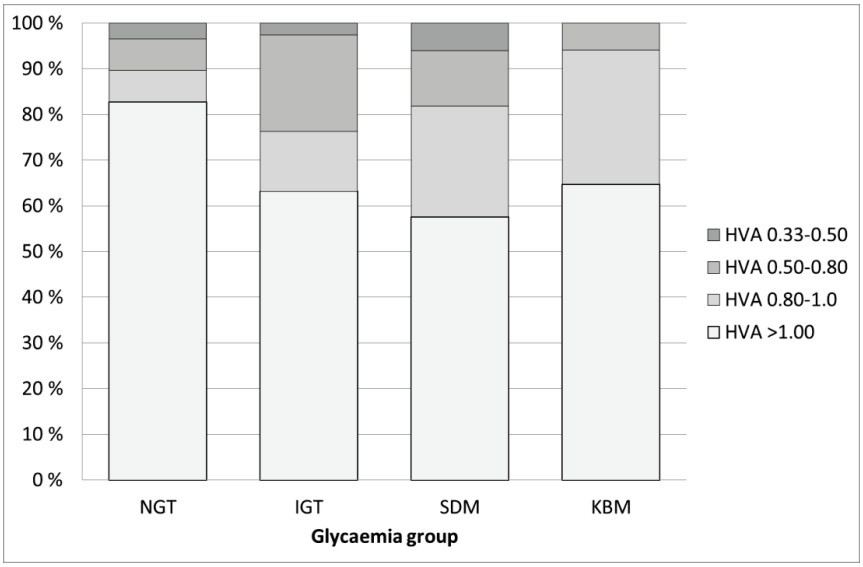


Figure 6.3a Presenting (habitual) visual acuity
BCVA, best corrected visual acuity; HVA, habitual visual acuity; IGT, impaired glucose tolerance; KDM, known diabetes mellitus; NGT, normal glucose tolerance; SDM, screen-detected diabetes

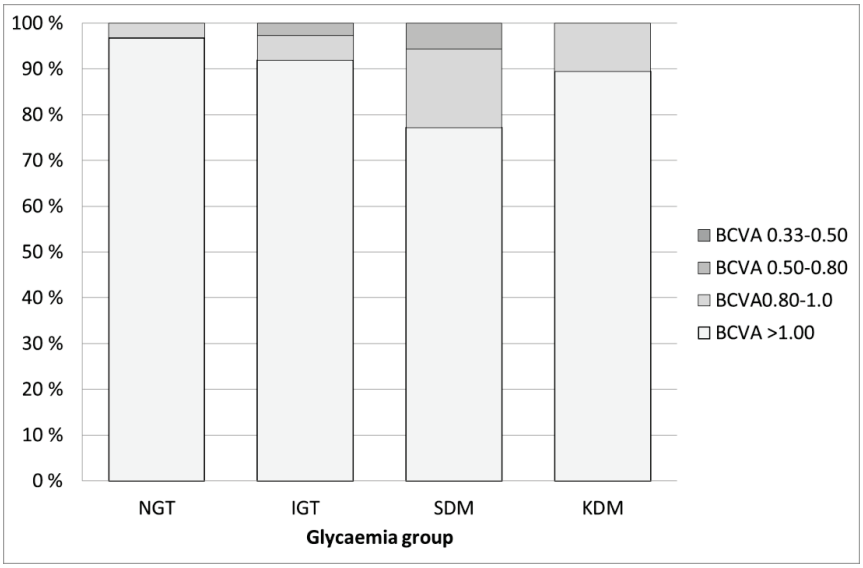


Figure 6.3b Best corrected visual acuity
BCVA, best corrected visual acuity; HVA, habitual visual acuity; IGT, impaired glucose tolerance; KDM, known diabetes mellitus; NGT, normal glucose tolerance; SDM, screen-detected diabetes

6.8 Paper V

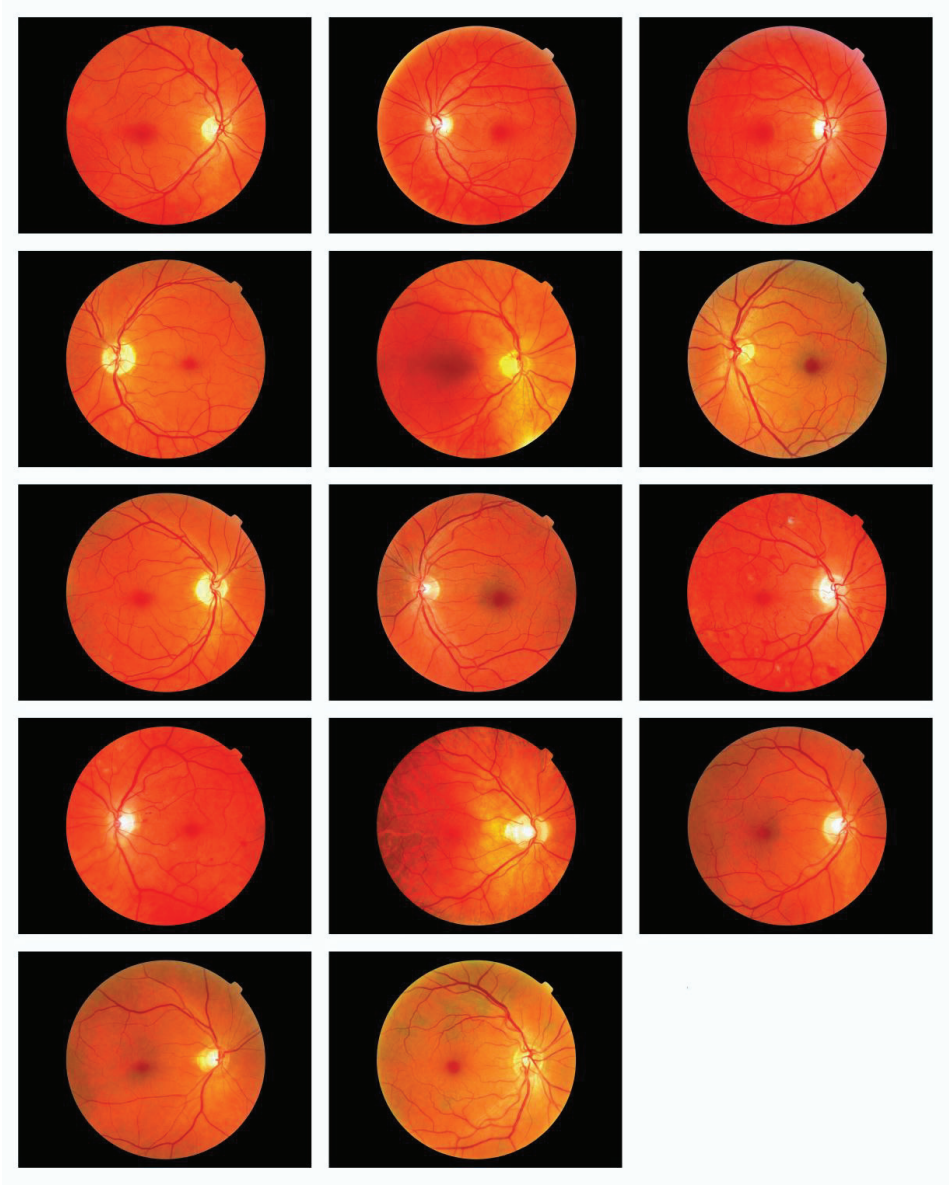
In all, 74 of the 101 eligible optometrists completed the VIMOC examination study. The participants were significantly more highly educated than the average Norwegian optometrist (Table 6.1). The two most common preferred methods of retinal examination were undilated indirect ophthalmoscopy (in 47% % of participants), and undilated retinal fundus photography (in 34% of participants). Multiple examination methods were reported for patients with diabetes. Twenty-three percent of optometrists reported undertaking dilated retinal examinations in patients with diabetes. The optometrists' assessment of diabetic retinopathy for all 14 retinal images is shown in Table 6.6, The images are shown in Figure 6.4. The overall sensitivity and specificity for detecting any retinopathy was 67% [95%CI (62, 72)] and 84% [95%CI (80, 89)], respectively. Optometrists with an MSc in clinical optometry had significantly higher sensitivity than optometrists with only a basic optometric education, 77% [95%CI (71, 84)] versus 63% [95%CI (56, 69)]. There was no association between either sensitivity or specificity and (1) the number of years the optometrist had been in practice, or (2) the optometrist's preferred method of retinal examination. The requirement for sensitivity of at least 80% and specificity of at least 95% was met by 24 (32%) and 31 (42%) of the optometrists, respectively. Of the optometrists with an MSc, 50% met the requirement for sensitivity and 45% met the requirement for specificity. For those optometrists with only a basic optometric education, the requirements for sensitivity and specificity were met by 25% and 39%, respectively. Only four optometrists (5%) met the required standard for both sensitivity and specificity. Patient management was dependent on retinal findings (Table 6.7). Report or referral to a GP or/and to an ophthalmologist was regarded appropriate for 99% of cases with true positive findings and 96% of cases with false positive findings. The referral rate to ophthalmologists was higher for moderate (92%) than for mild (62%) non-proliferative diabetic retinopathy. No further management was considered appropriate in 68% of cases with true negative findings and 66% of cases with false negative findings.

Table 6.6 Optometrists' VIMOC examination of retinal images for assessment of diabetic retinopathy, and appropriate patient management, by corresponding ophthalmologist grading of diabetic retinopathy and patient glycaemic status, Paper V

Image[a]	Patient status	Image evaluation			Optometrist consideration of further management					
		Ophthalmologist Grading of DR	Optometrist True findings of DR		None / Routine follow-up		Report / referral to general practitioner		Report / referral to ophthalmologist	
			n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	N	% (95% CI)
8	IGT	No DR	46	64 (52 to 75)	17	37 (23 to 51)	21	46 (31 to 60)	8	17 (6 to 28)
5	KDM	No DR	53	72 (61 to 82)	30	37 (43 to 70)	10	19 (8 to 29)	13	25 (13 to 36)
14	SDDM	No DR	61	82 (74 to 91)	31	51 (38 to 63)	18	30 (18 to 41)	12	20 (10 to 30)
13	SDDM	No DR	64	86 (79 to 94)	33	52 (39 to 64)	10	16 (7 to 25)	21	33 (21 to 44)
12	SDDM	No DR	68	92 (86 to 98)	58	85 (77 to 94)	4	6 (0 to 11)	6	9 (2 to 16)
11	KDM	No DR	71	96 (91 to 100)	61	86 (78 to 94)	2	3 (0 to 7)	8	11 (4 to 19)
2	NGT	No DR	73	99 (96 to 100)	66	90 (84 to 97)	4	5 (0 to 11)	3	4 (0 to 9)
1	NGT	Mild NPDR	23	31 (20 to 42)	1	4 (0 to 13)	8	35 (15 to 54)	14	61 (41 to 81)
6	IGT	Mild NPDR	39	53 (41 to 64)	1	3 (0 to 8)	10	26 (12 to 39)	28	72 (58 to 86)
3	NGT	Mild NPDR	40	54 (42 to 66)	0	0 (0 to 0)	19	48 (32 to 63)	21	53 (37 to 68)
7	DM	Mild NPDR	41	55 (44 to 67)	1	2 (0 to 7)	15	37 (22 to 51)	25	61 (46 to 76)
4	DM	Mild NPDR	57	77 (67 to 87)	2	4 (0 to 8)	20	35 (23 to 47)	35	61 (49 to 74)
9[b]	DM	Moderate NPDR	71	100 (100 to 100)	0	0 (0 to 0)	4	6 (0 to 11)	67	94 (89 to100)
10[c]	DM	Moderate NPDR	73	100 (100 to 100)	0	0 (0 to 0)	8	11 (4 to 18)	65	89 (82 to 96)

CI, confidence interval; DR, diabetic retinopathy; IGT, impaired glucose tolerance; KDM, known diabetes; NGT, normal glucose tolerance; NPDR, non-proliferative diabetic retinopathy; SDDM, screen-detected diabetes; VIMOC, Visual Identification and Management of Ophthalmological Conditions. [a]The number refers to the number in image presentation sequence of the VIMOC examination. Missing grading data from [b]3 and [c]1 optometrists

Figure 6.4 Retinal images assessed by optometrists in the VIMOC examination according to image presentation sequence, Paper V



Top row from left to right; image 1-3, second row from left to right; image 4-6, third row from left to right; image 7-9, fourth row from left to right; image 10-12, and bottom row from left to right; image 13-14

Table 6.7 Optometrists' (n=74) diagnostic accuracy for diabetic retinopathy, based on evaluation of the 14 retinal images (1036 evaluations) in the VIMOC examination, and their suggested patient management based on retinal findings, by true and false positive and negative ratings, Paper V

	Images with diabetic retinopathy (n=518)				Images without diabetic retinopathy (n=518)			
	Sensitivity True positive		False negative		Specificity True negative		False positive	
	n	%	N	%	n	%	n	%
Screening standard set to meet [a]	414	80	104	20	492	95	26	5
	n	% (95%CI)	n	% (95%CI)	n	% (95%CI)	n	% (95%CI)
Optometrists' image evaluation	348	67 (62 to 72)	170	32 (28 to 38)	437	84 (80 to 89)	81	16 (11 to 20)
Further management[b]								
None / Routine follow-up	5	1 (0 to 3)	113	66 (59 to 74)	296	68 (64 to 72)	3	4 (0 to 8)
Report / referral to GP	84	24 (20 to 29)	41	24 (18 to 21)	69	16 (12 to 19)	39	48 (37 to 59)
Report / referral to ophthalmologist	255	74 (70 to 79)	16	9 (5 to 14)	71	16 (13 to 20)	39	48 (37 to 59)

GP, general practitioner

[a] British Diabetic Association. Retinal photographic screening for diabetic eye disease. A British Diabetic Association Report. London: British Diabetic Association; 1997.

7. Discussion

7.1 Introduction

This is, to the best of my knowledge, the first national cross sectional description of optometric practice, and the first national study to estimate the prevalence of retinopathy among patients examined in optometric practice. This is also the first Norwegian study to describe the prevalence of retinopathy consistent with diabetic retinopathy in people without diabetes. The research contributes to the knowledge of utilization of eye care services in general, and to the knowledge of compliance with eye care guidelines among patients with diabetes in particular.

7.2 Reliability and validity

Reliability will be described in terms of the measures that have been made to assess reliability. Validity will be discussed in terms of: (1) internal validity, that is to what extent the findings and causes can be inferred from the sample population, and (2) external validity, that is to what extent the results can be applied beyond the sample population.

7.2.1 Reliability

In order to increase confidence in the data, and to provide a comprehensive understanding, this study applied and combined different research methods and collected data from different and independent population samples. This is referred to as *triangulation*. The following considerations of reliability should be kept in mind: (1) all questionnaires (Papers I, II, III, and IV), the practice registration form (Papers I and II), the clinical examination (Paper IV) and the VIMOC examination (Paper V) were assessed in pilot studies before study commencement, but reliability was not measured by test-retest, (2) the grading of diabetic retinopathy in the clinical study (Paper IV) was evaluated in terms of kappa analysis and the inter-rater reliability was very good (κ=0.75), (3) the optometrists' assessment of diabetic retinopathy, sensitivity and

specificity (Paper V), was evaluated against a “gold-standard” of 14 retinal images selected from images with 100% diagnostic agreement between two ophthalmologists in the clinical study (paper IV), and (4) the reported history of ocular disease (Papers I, II, III and IV), systemic disease (Papers I, II and III) and the optometrists’ clinical findings and ocular diagnosis (Papers I and II) were not verified against patient medical records.

7.2.2 Internal validity of the studies of optometric practice (Papers I, II and V)

A majority of the optometrists invited to participate in the questionnaire survey (65%) responded to the questionnaire and 42% of the questionnaire respondents participated in the practice registration study (Papers I and II). Questionnaire respondents were younger and more likely to be female than non-respondents. The practice registration form participants had more often had 3 years or more formal optometric education and worked in smaller communities than non-participants. In the VIMOC study, 112 (11%) optometrists participated in the study, of these 101 (90%) met the inclusion criteria and 74 (73%) completed the VIMOC examination (Paper V). Participants in the VIMOC examination more had often an MSc in clinical optometry and the right to employ diagnostic drugs for clinical evaluation, than non-participants. The questionnaire, practice registration form and VIMOC examination was completed by the optometrists in a consistent manner. Only one participant completed the practice registration form incorrectly; this form was excluded from analysis. The questionnaire and VIMOC examination were fully completed by the majority of the optometrists, and the practice registration form was fully completed for the majority of patient encounters. Respectively, 100%, 99.6% and 100% of the questionnaires were complete for the main variables of refraction, retinal examination and patient management. The optometrists recorded 19 (±3) of the 20 requested patient encounters. For the main variables of visual impairment, retinopathy, retinal examination and patient management, the forms were complete for 98.9%, 88%, 99.8% and 100% of the patient encounters, respectively. The main

variables in the VIMOC examination (diabetic retinopathy and patient management) were completed for all the image assessments.

Retinal examination, retinopathy and patient management

Retinal examination, detection of retinopathy and further patient management were not associated with either optometrist gender or practice community size. Although the frequency of retinal examination, detection of retinopathy, and referral patterns were associated with optometric education level (Technical College, 2 years at University College, 3 years at University College and MSc), the frequency of retinal examinations and detection of retinopathy was not significantly higher among optometrists with 3 years of University College education or an MSc (that is, ≥3 years of optometric education) than among optometrists with a Technical College education or 2 years of University College education (that is, < 3 years of optometric education. Further, there was no significant difference between optometrists with 3 years or more of optometric education and optometrists with less than 3 years of optometric education with regard to the number of patients considered to be in need of further medical management and referral pattern. The questionnaire results could have been affected by information bias, due to the optometrists' perception of expected standards and scope of clinical practice, that is, the optometrists may have reported what they believed to be the expected standard, rather than what they actually do in practice. In all, 88% of patients encountered had a retinal examination, as opposed to the expected level of 95%, based on the optometrists' responses to the questionnaire. However, this may reflect a tailoring of the routine examination according to patient age and the probability of having an ocular disease [159], as 95% of the patients who were examined were aged 55 years or older. In the practice registration study, 96% of patients with a known history of diabetes had their retina examined, whereas the majority of the participating optometrists (62%) reported in the questionnaire that they never undertake retinal examination in patients with known diabetes. This may reflect an expectation that this is beyond the scope of optometric

practice. However, it could also be that optometrists tailored their routine to facilitate case-finding of diabetic retinopathy as a consequence of the practice registration form increasing their awareness regarding retinal examination in general. It is unlikely that the difference in educational level between participating and non-participating optometrists in the practice registration study would result in overestimation or underestimation of the frequency of retinal examination, detection of retinopathy and patient referral for the sample. The difference between the reported frequency of retinal examination in the questionnaire and practice registration form is probably a result of tailoring the routine to the patient's age and the likelihood of ocular disease. Therefore, the frequency of retinal examinations, the age distribution of patients who have a retinal examination, the rate of detected retinopathy and the number of patient referrals and referral pattern are probably representative for the sample.

The quality of retinal assessment for diabetic retinopathy

Participants in the VIMOC examination (Paper V) were more likely to have an MSc in clinical optometry and the right to employ diagnostic drugs for clinical evaluation than non-participants. The main outcome variable of sensitivity was associated with formal education, while specificity was not. Optometrists with an MSc had a significantly higher sensitivity than optometrist with only a basic optometric education. Since optometrists with an MSc are more frequently represented in this study, and they have a higher sensitivity than optometrist with a basic optometric education, it is likely that the study overestimated sensitivity for the sample. However, the specificity of the optometrists' retinal image evaluation for diabetic retinopathy is likely to be representative, as specificity was not related to formal education.

7.2.3 External validity of the studies of optometric practice (Papers I, II and V)

How representative were the participating optometrists?

At the time of the questionnaire survey and practice registration study (2004-2005), 1,454 optometrists were registered with the Norwegian Registration Authority for Health Personnel; of these, 1,044 (72%) were members of the NOF. Mean age and gender distribution were similar for Norwegian Association of Optometrists members and non-members (Papers I and II). At the time of the VIMOC examination study (2011), 1,850 optometrists were registered with the Norwegian Registration Authority for Health Personnel; of these, 1,028 (56%) were active, full members of the NOF (Paper V). The difference in the proportion of optometrist being members of the NOF in 2004/2005 and 2011 reflects the fact that optometrists working in one of the large national private owned chains were not members in 2011, due to business policy relating to membership fees. Further, the number for 2011 excludes members who are registered on leave, which is mainly maternity leave / leave to care for children. The optometrists invited to participate in 2004/2005 (Papers I and II) and 2011(Paper V) were, at the time, representative of Norwegian optometrists in general.

The questionnaire respondents (Paper I) were younger and more frequently female than non-respondents, and optometrists who participated in the practice registration study (Papers I and II) also more frequently had 3 years or more formal optometric education. This is in a reflection of: (1) the development of Norwegian optometry education from Technical College to University College, (2) a shift from male to female dominance among students undertaking optometry education, and (3) an increase in the number of students studying optometry (from approximately 20 graduates per year prior to 1990, to approximately 40 per year between 1990 and 1999, and approximately 60 per year since 2000). The results found in the questionnaire survey and practice registration study

(Paper I and II) are likely to be representative for the invited sample, as discussed in 7.2.2.

The optometrists taking part in the VIMOC examination (Paper V) more frequently had an MSc and/or the right to use diagnostic ocular drugs than participants in the questionnaire survey and the practice registration study. This is partly explained by recent changes in the regulation of optometric practice and the availability of postgraduate optometric education in Norway. Norwegian optometrists were given the right to the requisition and use of certain ocular diagnostic drugs in 2004; postgraduate education in optometry has been available in Norway since 1998. In 2004, 132 optometrists had an MSc in clinical optometry; by 2011 this number had increased to 208. This selection bias could be a result of the specific nature of the study. First, highly educated optometrists with a special interest in diabetes and diabetic retinopathy were probably motivated to take part in the study. Second, the study may have intimidated optometrists with only a basic optometric education and those with modest knowledge of diabetes and diabetic retinopathy, and this may have prevented them from participating. For these reasons, the results observed in the VIMOC examination probably overestimated the diagnostic sensitivity of the invited sample, as discussed in 7.2.2.

How representative were the patients examined in optometric practice?

Patients examined in Norwegian optometric practice were not representative for the general Norwegian population. At the time of the study, 40% of the general Norwegian population were 45 years and older, whereas the majority (60%) of the patients in the practice registration study were over 45 years. The sample was, however, likely to be representative of patients seen for routine eye examinations in optometric practice. The scope for International extrapolation is limited, as the extent of optometric practice and organisation of eye care services differ worldwide, and patient characteristics may vary accordingly.

Retinal examination, retinopathy and patient management

The internal validity for the findings of the main outcome variables in the practice registration study was good, as discussed in 7.2.2. The selection bias does not appear to limit generalisation of the results (regarding retinal examination, detection of retinopathy, number of patient referrals and referral pattern) to general Norwegian optometric practice. International extrapolation of the findings cannot be claimed, as the scope of optometric practice differs in Europe [15] and worldwide [14].

The quality of retinal assessment for diabetic retinopathy

As discussed in 7.2.2, the internal validity of the findings for sensitivity was limited, and it is likely that sensitivity for detection of diabetic retinopathy was overestimated. Specificity was, however, representative for the sample. The results for diagnostic sensitivity for detecting diabetic retinopathy should not be generalised to Norwegian optometric practice. It is likely that sensitivity in general optometric practice is lower. However, specificity of the sample is likely to be representative of Norwegian optometric practice.

7.2.4 Internal validity of the studies of patients with diabetes (Papers II, III and IV)

Response rate in the questionnaire studies (Papers III and IV) was high, and the findings are probably representative for members of the NDA (Paper III) and the HUNT study sample (Paper IV). The analysed questionnaires were complete for age, gender and type of diabetes, and the internal validity of the questionnaire survey results are likely to be good. Some limitations should be considered, as the results were based on patients' self-reported answers. Recall bias can underestimate the prevalence of retinal examination and the time of the first eye examination, as insignificant events, such as examinations with no findings of retinopathy, can be forgotten [160]. On the other hand, social acceptance can lead to the prevalence of retinal examination being overestimated,

as respondents may perceive regular eye examinations as the expected, and most acceptable, form of healthcare [160]. Frequency of eye examinations can be overestimated due to the effect of *telescoping*, that is, the likelihood of remembering an event as being more recent than it actually is [160]. In contrast, the frequency of receipt of information about the importance of eye examination can be underestimated, due to recall-bias and social acceptance, as people may forget the information received, and in the case of non-compliance to recommended care, patients may deny having received such information. It has been shown that patients over-report eye examination twice as frequently as they under-report eye examination; in contrast, self-reported treatment of diabetes is more valid [160]. In conclusion, the results in this study could have overestimated the frequency of retinal examination in the samples. The rate of retinal examination in patients with diabetes was high in both the practice registration study (Papers I and II) and the clinical study (Paper IV). Some limitations should be considered with respect to the observed prevalence of diabetic retinopathy: (1) the sensitivity and specificity of the methods used for retinal examination, and (2) the formal optometric education of the optometrist participating in the practice registration study. The sensitivity and specificity of screening for diabetic retinopathy has been found to be lower using undilated direct ophthalmoscopy (Paper I and II) compared to dilated slit lamp examination, and lower using single-field, non-mydriatic photography (Paper IV) compared to multiple-field, mydriatic photography [143]. This could have contributed to an underestimated prevalence of retinopathy, both in the patients encountered in optometric practice and in the HUNT sample. Further, the prevalence of diabetic retinopathy among patients with diabetes examined in optometric practice (Papers I and II) is likely to have been underestimated as a result of the lower diagnostic sensitivity of the methods used, as well as the low diagnostic sensitivity of the optometrists' assessment of diabetic retinopathy (Papers II and V). This is particularly true for mild non-proliferative diabetic retinopathy. The reported history of retinopathy by members of the NDA (Paper III) could have underestimated the prevalence of diabetic retinopathy

because of unawareness of existing retinopathy as well as undiagnosed diabetic retinopathy. In conclusion, the actual prevalence of diabetic retinopathy could be higher than was found in all three of our studies.

7.2.5 External validity of the studies of patients with diabetes (Papers II, III and IV)

The prevalence of diabetes among patients attending Norwegian optometric practice is nearly twice the estimated prevalence of diabetes in the general Norwegian population [4], primarily due to a higher prevalence of diabetes among the patients under 75 years of age compared to the general population [4]. The members of the NDA represent a selected group of patients with diabetes, where patients with type 1 diabetes and patients with a long duration of diabetes are overrepresented. In addition, it is likely that members of patient organizations are self-selected in terms of other characteristics, for instance they may have a general interest in health, which is not reported in our study. In the sample from the Nord-Trøndelag Health Study, only a limited number of patients with diabetes were included. The external validity of the findings of diabetic retinopathy and eye care is limited because of selection bias. Furthermore, the methods used may have underestimated the prevalence of retinopathy in the samples, as discussed in 7.2.4. This limits the generalisation of the results to the general diabetic population.

7.3 Interpretation of the main findings

7.3.1 Patients encountered in Norwegian optometric practice

The majority of the patients seen in Norwegian optometric practice are 45 years or older, and women are more frequently examined than men. This is consistent with international studies of optometric and medical practice [161, 162]. The age distribution can be explained by the onset of presbyopia and probably reflects recommended follow-up intervals for different age groups [22]. Population studies in Australia and the US have shown that the prevalence of correctable visual impairment increases with increasing

age [104, 113, 114]. The clinical study (Paper IV) showed that 3% of adults have a correctable visual impairment and 6% have under-corrected refractive error. The rate of correctable visual impairment and under-corrected refractive error in the sample from the HUNT population is consistent both with international population-based studies and a small Norwegian population study. These studies, found that 1 to 6% of people have a correctable visual impairment [96, 104, 110-112] and 6 to 10% have under-corrected refractive error [112, 113]. Unfortunately, habitual visual acuity was not recorded in the practice registration study (Paper I), and the prevalence of a correctable visual impairment among patients examined in optometric practice could not be estimated.

7.3.1 The role of the Norwegian optometrist

Papers I, II and IV have shown that the routine optometric examination detects refractive error and correctable visual impairments, as well as cases of ocular disease. Furthermore, examinations undertaken in optometric practice include examination of visually impaired patients and patients with diagnosed ocular disease (Papers I and II). The prevalence of visual impairment among patients examined in optometric practice is similar, or higher, than both the reported prevalence in the Scandinavian general population and the estimated prevalence for Western Europe [101, 115, 163]. This reflects the role of the optometrist in examination, and probably rehabilitation, of the visually impaired. The higher rate of known history of glaucoma and age-related macular disease among patients examined in optometric practice (Paper I) compared to the prevalence reported in large population-based studies [117, 118], suggests a role for optometrists in the vision and eye care of patients with known ocular disease. Moreover, nearly half of the findings of cataracts and more than half of the findings of retinopathies in the practice registration study were detected in patients with no reported history of ocular or systemic disease (Papers I and II). This illustrates the role of the optometrists in case-finding of ocular disease. However, the diagnostic sensitivity of the retinal

examination undertaken in optometric practice is likely to be low, as the rate of vascular retinopathy in patients without diabetes and the rate of diabetic retinopathy in patients with diabetes were lower than previously found in international population studies [57, 164]. The incidence of known retinopathies missed during the routine optometric practice examination supports this view (Paper II). This low diagnostic sensitivity could be related to the investigative methods used and/or the optometrists' diagnostic skills. Undilated direct ophthalmoscopy has a lower diagnostic sensitivity and specificity for detection of retinal abnormalities than dilated indirect ophthalmoscopy and photographic grading [143, 165]. The low frequency of dilated fundus examinations in the practice registration study (Papers I and II) can be explained by the recent introduction of the right to employ diagnostic drugs for clinical evaluation and the fact that only a small number of optometrists were qualified to perform dilated ophthalmoscopy at the time of the study. Based on the results of the retinal examination undertaken as part of the routine optometric examination and a reported prevalence of retinopathy in Norway of 13.8 to 28% [64, 68], case-finding of diabetic retinopathy in optometric practice probably has an acceptable diagnostic specificity (Paper II). However, the diagnostic sensitivity is too low. This is supported by the findings in the VIMOC study (Paper V), where the sensitivity for detecting *any* diabetic retinopathy was low (67%) and the specificity was moderate (84%). A previous UK study of community optometrists showed a higher sensitivity (88%), but lower a specificity (69%) for retinal image assessment of *any* diabetic retinopathy; whereas a specially trained optometrist in the same study had a sensitivity of 86% and a specificity of 89% [145].

In conclusion, the routine optometric examination appears to be an unreliable method of screening for diabetic retinopathy, as it does not meet international screening criteria [138, 144]. The VIMOC examination study showed that only 5% of the participating optometrists satisfied the screening standard established by the British Diabetic Association of at least 80% sensitivity and 95% specificity [138]. It is important to bear in

mind, however, that the participating optometrists did not have specific training in screening for diabetic retinopathy, nor were they provided with a diabetic retinopathy grading scale or specific computer screens facilitating classification of diabetic retinopathy. The results indicate that formal training in screening for diabetic retinopathy is needed, in order to improve diagnostic accuracy. The current guidelines for optometric practice recommend retinal examination methods with high diagnostic sensitivity and specificity for the examination of patients with diabetes. These are either dilated slit lamp examination or dilated retinal photography [22]. This, along with improved formal training could establish optometric practice as a setting for screening for diabetic retinopathy. However, further research is needed to evaluate the effects of formal training and improved diagnostic techniques on diagnostic accuracy.

Based on our results (Papers I and II), we estimate that Norwegian optometrists undertake more than one million routine eye examinations per year, generating more than 60,000 referrals, 30,000 patient reports and 20,000 patient contacts to the GP. The rate of referrals is higher than previously reported [23]. This could be explained by discrepancies in the patient samples, as the previous study also included contact lens examinations and follow-ups, which are usually scheduled, even in healthy individuals, more frequently than routine eye examinations to prevent ocular complications associated with contact lens wear. The main causes of referral in Norwegian optometric practice (visual acuity, cataract, intraocular pressure, maculopathy and retinopathy) (Paper I), correspond with findings in the UK [166]. Our results suggest that optometrists make medical judgements, and that patient management depends on the optometrists' evaluation of ocular findings (Paper II). This observation should raise some concern. Retinal microvascular changes can be related to long-term hypertension, type 2 diabetes, impaired glucose metabolism, obesity, dyslipidemia, stroke and increased cardiovascular mortality [167]. Among patients with findings of vascular retinopathy and no known history of retinopathy or related systemic disease, one quarter of the patients

examined were not considered to be in need of further medical attention. This interpretation should, however, be treated with caution as the number of non-referrals were low and reasons for non-referral were not recorded. It is possible, for example, that a patient was not referred because they already had an upcoming medical appointment booked. If optometrists are taking on inappropriate medical responsibility, one possible explanation for it could be the lack of an established collaboration with medical practitioners and inadequate report and referral routines. Another explanation could be the lack of formal integration within the healthcare system. The reported collaboration with other healthcare professionals varied, with nearly one out of five optometrists stating that they have no collaboration with either GPs or ophthalmologists. The Norwegian Association of Optometrists has issued guidelines for clinical practice [22] which include guidelines for referral. In general, a referral should be made if the routine examination reveals findings which indicate that the expertise of other healthcare professionals is necessary to ensure best possible healthcare. Future research should address the awareness of, and the adherence to, these guidelines by Norwegian optometrists. Historically, Norwegian optometrists have referred patients directly to ophthalmologists. In our study (Papers I and II), the majority of referrals were to a GP. This could be explained by the implementation of the list system in Norwegian general practice in 2001, which at the time of the study required referral to an ophthalmologist to be made by the patient's GP. Paper I concluded that a direct referral route from optometrist to ophthalmologist should be established, and as of January 2009, Norwegian optometrists have been given the opportunity to refer directly to ophthalmologists [20]. In the hearing procedure of this regulation there were arguments both for and against the regulation. The effect of this regulation should be addressed in future health services research.

7.3.2 Eye examination, diabetic retinopathy and visual impairment in diabetes

In our study (Paper III), the vast majority of patients with diabetes (78%) had their eyes examined according to current guidelines. Diabetes duration and having received information about potential eye complications were independently associated with eye care according to the guidelines. The proportion of patients who had been examined according to guidelines was significantly higher than had been previously reported in Norway [146], and similar or higher than found in international cross-sectional surveys of the general diabetic population [146, 147, 149-152]. This may reflect an actual improvement in the management of ocular health in patients with diabetes, in accordance with findings reported in studies of eye care in patients with diabetes in the US between 1988 and 2002 [147], in Australia between 2003 and 2005 [148] and in Germany between 1999 and 2008 [149]. Other current studies undertaken in Norway also indicate improved eye care [64, 153], although reported follow-up according to guidelines was lower than found in our study. This discrepancy could be explained by selection bias, as discussed in 7.3.5. Half of the NDA questionnaire respondents had not received information about the importance of regular eye examinations from their GP (Paper III). The vast majority of the respondents used some form of optical correction. Patients with diabetes are frequently examined in Norwegian optometric practice and case-finding of diabetic retinopathy does occur in optometric practice. Studies have shown that the use of eye care services in diabetes is associated with the use of health services in general and with health promotion campaigns [148, 150, 151]. On the one hand, this suggests a role for optometrists in promoting regular eye examination and providing education to patients with diabetes. On the other hand, the promotion of regular eye examination could raise questions about the motives and integrity of optometrists, as they have a financial interest in patients having regular eye examinations.

Our study showed a prevalence of diabetic retinopathy of 11 to 17% among patients with diabetes (Papers II, III and IV). This corresponds with the total prevalence of diabetic retinopathy reported in a small Norwegian community [68]. However, it is lower than the reported prevalence in population-based studies from the US, UK, Denmark and Australia [33, 59-62, 65] and a recent Norwegian population-based screening study (28%) [64]. The prevalence of diabetic retinopathy in our study is likely to have been underestimated as a result of bias, as described in section 7.2. Therefore, estimation of the prevalence of diabetic retinopathy in the general diabetic population in Norway, based on this study, is questionable.

In general, the prevalence of visual impairment was higher among patients examined in optometric practice than among the sample for the HUNT study (Papers I and IV). This could have been a result of people who experience visual problems being more likely to see an optometrist than people who do not experience any symptoms and people who have visual problems being less likely to participate in a population study if they are already under the care of an ophthalmologist or optometrist. The prevalence of visual impairment in our study was higher in patients with diabetes than in patients without diabetes (Paper I). The prevalence of visual impairment and low vision is consistent with the lower end of population-based reported prevalences of 3.8 to 13.1% and 2.9 to 6.2%, respectively [59-61, 122, 125, 168]. However, we did not explore the reasons for the visual impairment; visual impairment caused by diabetic retinopathy in our study could be even lower because our findings may have included visual impairment related to concurrent ocular disease [59, 122]. However, the low prevalence of low vision may also suggest good compliance with recommended eye care among patients with diabetes in our study.

8. Implications

Optometric practice is an easily accessible place for primary eye care in the Norwegian healthcare system. The routine optometric examination detects correctable visual impairment and under-corrected refractive error and may promote case-finding of ocular disease and retinal manifestations of systemic disease. However, the diagnostic sensitivity of the retinal examination appears to be low. Measures should be taken to improve diagnostic sensitivity.

Optometrists probably do take on medical responsibilities, and their clinical decision making and referral habits should be addressed. Consensus on patient management, referral practice and general collaboration with GPs and ophthalmologists should be established to ensure best possible patient care.

Further research is needed to provide estimates of the prevalence of diabetic retinopathy and visual impairment among patients with diabetes in Norway.

In patients with diabetes, eye examination in accordance with national professional guidelines is associated with diabetes duration and having received information about potential eye complications in diabetes. Most patients with diabetes use some optical correction and the number of patients with diabetes examined in optometric practice is high. Optometric practice has the potential to develop itself into a viable setting for patient education and to play an important role in screening for diabetic retinopathy. However, for optometrists to become part of a screening programme for diabetic retinopathy, targeted formal optometric training and mandatory continuing optometric education in screening for diabetic retinopathy is required.

Postscript

Since I began my research, the NOF has issued its clinical guidelines for optometric practice (2005), Norwegian optometrists have been given the opportunity to refer directly to an ophthalmologist (2009), and the first national professional guidelines for diabetes have been issued (2009).

As the population grows older and the prevalence of systemic disease affecting the eye increases, the demand for eye care services will grow. Optometrists could provide a key function in primary eye care in Norway. Higher education and research are the foundations of professional development. The educational system must adapt to meet the future demands of the profession, the health authorities and the general public, as the scope of optometry in Norway is likely to change. The Norwegian Health Authorities, the optometry profession (NOF) and optometry educational establishments (such as Buskerud University College) have a responsibility to ensure that the competency of optometrists and the quality of optometric practice meet the high standards required and provide the necessary eye care for specific groups in the population. In the UK, where optometrists are a formal part of the National Health Service, specialisation and accreditation have been implemented for specific areas such as shared care in diabetes. Further optometric research should address vision and eye care in the general population, the quality of Norwegian optometric practice, and models for eye care in community health services.

References

1. Wild, S., et al., *Global prevalence of diabetes: estimates for the year 2000 and projections for 2030.* Diabetes Care, 2004. **27**(5): p. 1047-53.
2. Birkeland, K., *Kan vi forebygge diabetes? [Can diabetes be prevented?].* Tidsskrift for Den Norske Laegeforening, 2002. **122**(2): p. 155.
3. Jervell, J., *Diabetes i et internasjonalt perspektiv [Diabetes in international perspective].* Tidsskrift for Den Norske Laegeforening, 2000. **120**(22): p. 2686-9.
4. Stene, L.C., et al., *Hvor mange har diabetes mellitus i Norge? [Prevalence of diabetes mellitus in Norway].* Tidsskrift for Den Norske Laegeforening, 2004. **124**(11): p. 1511-4.
5. Porta, M. and Bandello, F., *Diabetic retinopathy A clinical update.* Diabetologia, 2002. **45**(12): p. 1617-34.
6. Stefansson, E., et al., *Screening and prevention of diabetic blindness.* Acta Ophthalmologica Scandinavica, 2000. **78**(4): p. 374-85.
7. Javitt, J.C. and Aiello, L.P., *Cost-effectiveness of detecting and treating diabetic retinopathy.* Annals of Internal Medicine, 1996. **124**(1 Pt 2): p. 164-9.
8. Schmid, K.L., et al., *The detection of diabetic retinopathy by Australian optometrists.* Clinical and Experimental Optometry, 2002. **85**(4): p. 221-8.
9. Olson, J.A., et al., *A comparative evaluation of digital imaging, retinal photography and optometrist examination in screening for diabetic retinopathy.* Diabetic Medicine, 2003. **20**(7): p. 528-34.
10. Hulme, S.A., et al., *Evaluation of a district-wide screening programme for diabetic retinopathy utilizing trained optometrists using slit-lamp and Volk lenses.* Diabetic Medicine, 2002. **19**(9): p. 741-5.
11. Prasad, S., et al., *Effectiveness of optometrist screening for diabetic retinopathy using slit-lamp biomicroscopy.* Eye, 2001. **15**(Pt 5): p. 595-601.
12. *Optometry*. Merriam-Webster Online Dictionary 2008 [cited 2008 November 13]; Available from: http://www.merriam-webster.com/dictionary/optometry
13. *Optometrist*. Merriam-Webster Online Dictionary 2008 [cited 2008 November 13]; Available from: http://www.merriam-webster.com/dictionary/optometrist.
14. Di Stefano, A., *World optometry: the challenges of leadership for the new millennium.* Optometry, 2002. **73**(6): p. 339-50.
15. Hamakiotes, D.S. and Thal, L.S., *The unification of European optometry: how the profession will change after 1992.* Journal of the American Optometric Association, 1991. **62**(12): p. 904-13.
16. World Council of Optometry. *Global Vision and Worldwide Opportunity*. World Council of Optometry. About us. 2012 [cited 2012 17. March]; Available from: http://www.worldoptometry.org/site/awdep.asp?depnum=23631 http://www.worldoptometry.org/en/WOF/about-us/background.cfm.
17. Norges Optikerforbund. *Norges Optikerforbunds strategiplan*. 2012 [cited 2012 17 March]; Available from: http://www.synsinformasjon.no/strategiplan.cfm?FuseAction=GenPage&pWebprofilfunkid=12726.
18. *Forskrift for godkjenning m.v. av optikere*, in *FOR-1988-04-22 nr. 0309.* 1988.
19. *Forskrift om rekvirering og utlevering av legemidler fra apotek*, in *FOR-1998-04-27-455* 1998, Helse- og omsorgsdepartementet.
20. *Forskrift om stønad til dekning av utgifter til undersøkelse og behandling hos lege*, in *FOR-2009-06-25-949* 2009, Helse og omsorgsdepartementet.
21. *Lov om helsepersonell m.v. (helsepersonelloven)*, in *LOV-1999-07-02-64*, Helse- og omsorgsdepartementet, Editor. 1999.
22. Norges Optikerforbund, *Retningslinjer i klinisk optometri*. 2005, Norges Optikerforbund: Oslo.
23. Lid, J., et al., *Optikerens rolle som viderehenviser til annet helsepersonell [The role of optometrist in referral to other health care providers]* Optikeren, 1996(6): p. 37-40.
24. Midthjell, K., et al., *Urovekkende høy forekomst av uoppdaget type 2-diabetes og nedsatt glukosetoleranse hos voksne i Nord-Trøndelag.* Norsk Epidemiologi, 2005. **15**(Supplement 1): p. 30.
25. McCance, D.R., et al., *Comparison of tests for glycated haemoglobin and fasting and two hour plasma glucose concentrations as diagnostic methods for diabetes.* BMJ, 1994. **308**(6940): p. 1323-8.

26. Helsedirektoratet, *Nasjonale faglige retningslinjer (IS-1674). Diabetes - Forebygging, diagnostikk og behandling [National professional guidelines. Diabetes - Prevention, diagnostics and treatment].* 2009, Helsedirektoratet: Oslo.
27. van Leiden, H.A., et al., *Risk factors for incident retinopathy in a diabetic and nondiabetic population: the Hoorn study.* Archives of Ophthalmology, 2003. **121**(2): p. 245-51.
28. Wong, T.Y., et al., *Relation between fasting glucose and retinopathy for diagnosis of diabetes: three population-based cross-sectional studies.* Lancet, 2008. **371**(9614): p. 736-743.
29. Diabetes Prevention Program Research Group, *The prevalence of retinopathy in impaired glucose tolerance and recent-onset diabetes in the Diabetes Prevention Program.* Diabetic Medicine, 2007. **24**(2): p. 137-44.
30. Colagiuri, S., et al., *Glycemic thresholds for diabetes-specific retinopathy: implications for diagnostic criteria for diabetes.* Diabetes Care, 2011. **34**(1): p. 145-50.
31. Murtagh, J.E., *Diabetes mellitus: the general practitioner's perspective.* Clinical & Experimental Optometry, 1999. **82**(2-3): p. 74-79.
32. Rajala, U., et al., *Prevalence of retinopathy in people with diabetes, impaired glucose tolerance, and normal glucose tolerance.* Diabetes Care, 1998. **21**(10): p. 1664-9.
33. Tapp, R.J., et al., *The prevalence of and factors associated with diabetic retinopathy in the Australian population.* Diabetes Care, 2003. **26**(6): p. 1731-7.
34. Cugati, S., et al., *Five-year incidence and progression of vascular retinopathy in persons without diabetes: the Blue Mountains Eye Study.* Eye, 2006. **20**(11): p. 1239-1245.
35. Wong, T.Y., et al., *Three-Year Incidence and Cumulative Prevalence of Retinopathy: The Atherosclerosis Risk in Communities Study.* American Journal of Ophthalmology, 2007. **143**(6): p. 970-976.
36. Swann, P.G., *Non-retinal ocular changes in diabetes.* Clinical and Experimental Optometry, 1999. **82**(2-3): p. 43-46.
37. North, R., *Early ocular and non-ocular indications of diabetes mellitus.* Ophthalmic and Physiological Optics, 1998. **18**(2): p. 167-172.
38. Jeganathan, V.S., et al., *Ocular associations of diabetes other than diabetic retinopathy.* Diabetes Care, 2008. **31**(9): p. 1905-12.
39. Zhang, X., et al., *Diabetes mellitus and visual impairment: national health and nutrition examination survey, 1999-2004.* Archives of Ophthalmology, 2008. **126**(10): p. 1421-7.
40. Wiemer, N.G., et al., *Refractive properties of the healthy human eye during acute hyperglycemia.* Graefes Archive for Clinical and Experimental Ophthalmology, 2008. **246**(7): p. 993-8.
41. Lin, S.F., et al., *Transient Hyperopia after Intensive Treatment of Hyperglycemia in Newly Diagnosed Diabetes.* Ophthalmologica, 2008. **223**(1): p. 68-71.
42. Wiemer, N.G., et al., *Measuring the refractive properties of the diabetic eye during blurred vision and hyperglycaemia using aberrometry and Scheimpflug imaging.* Acta Ophthalmologica, 2009. **87**(2): p. 176-82.
43. Rowe, N.G., et al., *Diabetes, fasting blood glucose and age-related cataract: the Blue Mountains Eye Study.* Ophthalmic Epidemiology, 2000. **7**(2): p. 103-14.
44. Klein, B.E., et al., *Older-onset diabetes and lens opacities. The Beaver Dam Eye Study.* Ophthalmic Epidemiology, 1995. **2**(1): p. 49-55.
45. Mukesh, B.N., et al., *Development of cataract and associated risk factors: the Visual Impairment Project.* Archives of Ophthalmology, 2006. **124**(1): p. 79-85.
46. Klein, B.E., et al., *Diabetes, cardiovascular disease, selected cardiovascular disease risk factors, and the 5-year incidence of age-related cataract and progression of lens opacities: the Beaver Dam Eye Study.* American Journal of Ophthalmology, 1998. **126**(6): p. 782-90.
47. Murtha, T. and Cavallerano, J., *The management of diabetic eye disease in the setting of cataract surgery.* Current Opinion in Ophthalmology, 2007. **18**(1): p. 13-8.
48. Negahban, K. and Chern, K., *Cataracts associated with systemic disorders and syndromes.* Current Opinion in Ophthalmology, 2002. **13**(6): p. 419-22.
49. Saxena, S., et al., *Five-year incidence of cataract in older persons with diabetes and pre-diabetes.* Ophthalmic Epidemiology, 2004. **11**(4): p. 271-7.
50. Skrivarhaug, T., et al., *Low cumulative incidence of proliferative retinopathy in childhood-onset type 1 diabetes: a 24-year follow-up study.* Diabetologia, 2006. **49**(10): p. 2281-90.

51. Klein, R., et al., *The Wisconsin Epidemiologic Study of Diabetic Retinopathy: XVII. The 14-year incidence and progression of diabetic retinopathy and associated risk factors in type 1 diabetes.* Ophthalmology, 1998. **105**(10): p. 1801-15.
52. Wong, T.Y., et al., *Diabetic retinopathy in a multi-ethnic cohort in the United States.* American Journal of Ophthalmology, 2006. **141**(3): p. 446-455.
53. Grauslund, J., et al., *Prevalence and 25 year incidence of proliferative retinopathy among Danish type 1 diabetic patients.* Diabetologica, 2009. **52**(9): p. 1829-35.
54. Klein, R., et al., *The Wisconsin epidemiologic study of diabetic retinopathy. IV. Diabetic macular edema.* Ophthalmology, 1984. **91**(12): p. 1464-74.
55. Klein, R., et al., *The Wisconsin Epidemiologic Study of Diabetic Retinopathy XXIII: the twenty-five-year incidence of macular edema in persons with type 1 diabetes.* Ophthalmology, 2009. **116**(3): p. 497-503.
56. Klein, R., et al., *The Wisconsin Epidemiologic Study of Diabetic Retinopathy. XV. The long-term incidence of macular edema.* Ophthalmology, 1995. **102**(1): p. 7-16.
57. Williams, R., et al., *Epidemiology of diabetic retinopathy and macular oedema: a systematic review.* Eye, 2004. **18**(10): p. 963-83.
58. Younis, N., et al., *Prevalence of diabetic eye disease in patients entering a systematic primary care-based eye screening programme.* Diabetic Medicine, 2002. **19**(12): p. 1014-21.
59. Scanlon, P.H., et al., *Visual acuity measurement and ocular co-morbidity in diabetic retinopathy screening.* British Journal of Ophthalmology, 2008. **92**(6): p. 775-8.
60. Hove, M.N., et al., *The prevalence of retinopathy in an unselected population of type 2 diabetes patients from Arhus County, Denmark.* Acta Ophthalmologica Scandinavica, 2004. **82**(4): p. 443-8.
61. Broadbent, D.M., et al., *Prevalence of diabetic eye disease in an inner city population: the Liverpool Diabetic Eye Study.* Eye, 1999. **13**: p. 160-5.
62. Mitchell, P., et al., *Prevalence of diabetic retinopathy in an older community. The Blue Mountains Eye Study.* Ophthalmology, 1998. **105**(3): p. 406-11.
63. *Lov om folketrygd (folketrygdloven)*, in *LOV-1997-02-28-19*. 1997, Arbeidsdepartementet.
64. Kilstad, H.N., et al., *Prevalence of diabetic retinopathy in Norway: report from a screening study.* Acta Ophthalmologica, 2011.
65. Knudsen, L.L., et al., *The North Jutland County Diabetic Retinopathy Study: population characteristics.* British Journal of Ophthalmology, 2006. **90**(11): p. 1404-9.
66. Sloan, F.A., et al., *Changes in incidence of diabetes mellitus-related eye disease among US elderly persons, 1994-2005.* Archives of Ophthalmology, 2008. **126**(11): p. 1548-53.
67. Klein, R., et al., *The Wisconsin Epidemiologic Study of Diabetic Retinopathy: XXII the twenty-five-year progression of retinopathy in persons with type 1 diabetes.* Ophthalmology, 2008. **115**(11): p. 1859-68.
68. Hapnes, R. and Bergrem, H., *Diabetic eye complications in a medium sized municipality in southwest Norway.* Acta Ophthalmologica Scandinavica, 1996. **74**(5): p. 497-500.
69. Bertelsen, G., et al., *Tromso eye study: prevalence and risk factors of diabetic retinopathy.* Acta Ophthalmologica, 2012. [Epub ahead of print]
70. Wilkinson, C.P., et al., *Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales.* Ophthalmology, 2003. **110**(9): p. 1677-82.
71. Klein, R., et al., *The Wisconsin epidemiologic study of diabetic retinopathy. II. Prevalence and risk of diabetic retinopathy when age at diagnosis is less than 30 years.* Archives of Ophthalmology, 1984. **102**(4): p. 520-6.
72. Klein, R., et al., *The Wisconsin epidemiologic study of diabetic retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years.* Archives of Ophthalmology, 1984. **102**(4): p. 527-32.
73. Klein, R., et al., *The Wisconsin epidemiologic study of diabetic retinopathy. XI. The incidence of macular edema.* Ophthalmology, 1989. **96**(10): p. 1501-10.
74. van Leiden, H.A., et al., *Blood pressure, lipids, and obesity are associated with retinopathy: the hoorn study.* Diabetes Care, 2002. **25**(8): p. 1320-5.
75. Klein, B.E., et al., *A cohort study of the relationship of diabetic retinopathy to blood pressure.* Archives of Ophthalmology, 1995. **113**(5): p. 601-6.
76. Klein, R., et al., *The association of atherosclerosis, vascular risk factors, and retinopathy in adults with diabetes : the atherosclerosis risk in communities study.* Ophthalmology, 2002. **109**(7): p. 1225-34.

77. Chew, E.Y., et al., *Association of elevated serum lipid levels with retinal hard exudate in diabetic retinopathy. Early Treatment Diabetic Retinopathy Study (ETDRS) Report 22.* Archives of Ophthalmology, 1996. **114**(9): p. 1079-84.
78. Lim, L.S. and Wong, T.Y., *Lipids and diabetic retinopathy.* Expert Opinion on Biological Therapy, 2012. **12**(1): p. 93-105.
79. Singh, R., et al., *Diabetic retinopathy: an update.* Indian Journal of Ophthalmology, 2008. **56**(3): p. 178-88.
80. Mohamed, Q., et al., *Management of diabetic retinopathy: a systematic review.* JAMA, 2007. **298**(8): p. 902-16.
81. *The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group.* New England Journal of Medicine, 1993. **329**(14): p. 977-86.
82. *Retinopathy and nephropathy in patients with type 1 diabetes four years after a trial of intensive therapy. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group.* New England Journal of Medicine, 2000. **342**(6): p. 381-9.
83. UK Prospective Diabetes Study Group, *Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group.* Lancet, 1998. **352**(9131): p. 837-53.
84. UK Prospective Diabetes Study Group, *Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. UK Prospective Diabetes Study Group.* BMJ, 1998. **317**(7160): p. 703-13.
85. Keech, A.C., et al., *Effect of fenofibrate on the need for laser treatment for diabetic retinopathy (FIELD study): a randomised controlled trial.* Lancet, 2007. **370**(9600): p. 1687-97.
86. Ismail-Beigi, F., et al., *Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial.* Lancet, 2010. **376**(9739): p. 419-30.
87. *Photocoagulation for diabetic macular edema: Early Treatment Diabetic Retinopathy Study Report no. 4. The Early Treatment Diabetic Retinopathy Study Research Group.* International Ophthalmology Clinics, 1987. **27**(4): p. 265-72.
88. *Photocoagulation treatment of proliferative diabetic retinopathy. Clinical application of Diabetic Retinopathy Study (DRS) findings, DRS Report Number 8. The Diabetic Retinopathy Study Research Group.* Ophthalmology, 1981. **88**(7): p. 583-600.
89. VISION2020. *What Causes Blindness and how does VISION 2020 Fight it?* VISION 2020. What is avoidable blindness? 2012 [cited 2009 12 June]; Available from: http://www.vision2020.org/main.cfm?type=WHATVISION2020 http://www.vision2020.org/main.cfm?type=WHATISBLINDNESS.
90. Pascolini, D. and Mariotti, S.P., *Global estimates of visual impairment: 2010.* British Journal of Ophthalmology, 2011. **96**(5): p. 614-8.
91. WHO, *ICD-10. Statistical classification of diseases and related healthproblems - tenth revision*. 1992, Geneva: World Health Organization.
92. Nowakowski, R.W., *Primary low vision care*. 1994, Norwalk, Connecticut: Appleton & Lange.
93. Farrall, H., *Optometric management of visual handicap*. 1991, Oxford: Blackwell Scientific Publications Ltd.
94. Vitale, S., et al., *Prevalence of visual impairment in the United States.* JAMA, 2006. **295**(18): p. 2158-63.
95. *FOR-2004-01-19-298 Forskrift om førerkort m.m.* 2004, Samferdselsdepartementet.
96. Foran, S., et al., *Correctable visual impairment in an older population: the Blue Mountains Eye Study.* American Journal of Ophthalmology, 2002. **134**(5): p. 712-9.
97. Resnikoff, S., et al., *Global data on visual impairment in the year 2002.* Bulletin of the World Health Organization, 2004. **82**: p. 844-851.
98. Kelliher, C., et al., *Trends in blind registration in the adult population of the Republic of Ireland 1996-2003.* British Journal of Ophthalmology, 2006. **90**(3): p. 367-71.
99. Bunce, C. and Wormald, R., *Leading causes of certification for blindness and partial sight in England & Wales.* BMC Public Health, 2006. **6**: p. 58.

100. Bunce, C., et al., *Causes of blind and partial sight certifications in England and Wales: April 2007-March 2008.* Eye (Lond), 2010. **24**(11): p. 1692-9.
101. Buch, H., et al., *Prevalence and causes of visual impairment and blindness among 9980 Scandinavian adults: the Copenhagen City Eye Study.* Ophthalmology, 2004. **111**(1): p. 53-61.
102. Gunnlaugsdottir, E., et al., *Prevalence and causes of visual impairment and blindness in Icelanders aged 50 years and older: the Reykjavik Eye Study.* Acta Ophthalmologica, 2008. **86**(7): p. 778-785.
103. Buch, H., et al., *The prevalence and causes of bilateral and unilateral blindness in an elderly urban Danish population. The Copenhagen City Eye Study.* Acta Ophthalmologica Scandinavica, 2001. **79**(5): p. 441-9.
104. Munoz, B., et al., *Causes of blindness and visual impairment in a population of older Americans: The Salisbury Eye Evaluation Study.* Archives of Ophthalmology, 2000. **118**(6): p. 819-25.
105. Attebo, K., et al., *Visual acuity and the causes of visual loss in Australia. The Blue Mountains Eye Study.* Ophthalmology, 1996. **103**(3): p. 357-64.
106. Klaver, C.C., et al., *Age-specific prevalence and causes of blindness and visual impairment in an older population: the Rotterdam Study.* Archives of Ophthalmology, 1998. **116**(5): p. 653-8.
107. Klein, R., et al., *The Beaver Dam Eye Study: visual acuity.* Ophthalmology, 1991. **98**(8): p. 1310-5.
108. Gunnlaugsdottir, E., et al., *Five-year incidence of visual impairment and blindness in older Icelanders: the Reykjavik Eye Study.* Acta Ophthalmologica, 2010. **88**(3): p. 358-66.
109. Sjøstrand, J., et al., *The decline in visual acuity in elderly people with healthy eyes or eyes with early age-related maculopathy in two Scandinavian population samples.* Acta Ophthalmologica, 2011. **89**(2): p. 116-23.
110. VanNewkirk, M.R., et al., *Cause-specific prevalence of bilateral visual impairment in Victoria, Australia: the Visual Impairment Project.* Ophthalmology, 2001. **108**(5): p. 960-7.
111. Cedrone, C., et al., *Age-specific changes in the prevalence and management of optically correctable visual impairment between 1988 and 2000: the Ponza Eye Study.* Eye (Lond), 2009. **23**(3): p. 522-9.
112. Sundling, V., *Visual acuity and correctable visual impairment among Norwegian 65-year olds.* Scandinavian Journal of Optometry and Visual Science 2011. **4**(1): p. 23-29.
113. Thiagalingam, S., et al., *Factors associated with undercorrected refractive errors in an older population: the Blue Mountains Eye Study.* British Journal of Ophthalmology, 2002. **86**(9): p. 1041-5.
114. Liou, H.L., et al., *Prevalence and predictors of undercorrected refractive errors in the Victorian population.* American Journal of Ophthalmology, 1999. **127**(5): p. 590-6.
115. Congdon, N., et al., *Causes and prevalence of visual impairment among adults in the United States.* Archives of Ophthalmology, 2004. **122**(4): p. 477-85.
116. Congdon, N., et al., *Prevalence of cataract and pseudophakia/aphakia among adults in the United States.* Archives of Ophthalmology, 2004. **122**(4): p. 487-94.
117. Friedman, D.S., et al., *Prevalence of open-angle glaucoma among adults in the United States.* Archives of Ophthalmology, 2004. **122**(4): p. 532-8.
118. Friedman, D.S., et al., *Prevalence of age-related macular degeneration in the United States.* Archives of Ophthalmology, 2004. **122**(4): p. 564-72.
119. Kempen, J.H., et al., *The prevalence of diabetic retinopathy among adults in the United States.* Archives of Ophthalmology, 2004. **122**(4): p. 552-63.
120. Bamashmus, M.A., et al., *Causes of blindness and visual impairment in the West of Scotland.* Eye (Lond), 2004. **18**(3): p. 257-61.
121. Rohrschneider, K. and Greim, S., *Erblindungsursachen in Baden von 1980 bis 1999 [Epidemiology of blindness in Baden, Germany].* Klinische Monatsblatter fur Augenheilkunde, 2004. **221**(2): p. 116-21.
122. Prasad, S., et al., *Prevalence of blindness and visual impairment in a population of people with diabetes.* Eye, 2001. **15**(Pt 5): p. 640-3.
123. Jeppesen, P. and Bek, T., *The occurrence and causes of registered blindness in diabetes patients in Arhus County, Denmark.* Acta Ophthalmologica Scandinavica, 2004. **82**(5): p. 526-30.
124. Zoega, G.M., et al., *Screening compliance and visual outcome in diabetes.* Acta Ophthalmologica Scandinavica, 2005. **83**(6): p. 687-90.

125. Olafsdottir, E., et al., *Visual acuity in a population with regular screening for type 2 diabetes mellitus and eye disease.* Acta Ophthalmologica Scandinavica, 2007. **85**(1): p. 40-5.
126. Grauslund, J., et al., *Blindness in a 25-year follow-up of a population-based cohort of Danish type 1 diabetic patients.* Ophthalmology, 2009. **116**(11): p. 2170-4.
127. Klein, R., et al., *The 25-year incidence of visual impairment in type 1 diabetes mellitus the Wisconsin Epidemiologic Study of Diabetic Retinopathy.* Ophthalmology, 2010. **117**(1): p. 63-70.
128. Harris, M.I., et al., *Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis.* Diabetes Care, 1992. **15**(7): p. 815-9.
129. Voutilainen-Kaunisto, R.M., et al., *Occurrence and predictors of retinopathy and visual acuity in Type 2 diabetic patients and control subjects. 10-year follow-up from the diagnosis.* Journal of Diabetes and its Complications, 2001. **15**(1): p. 24-33.
130. Thomas, R.L., et al., *Incidence of diabetic retinopathy in people with type 2 diabetes mellitus attending the Diabetic Retinopathy Screening Service for Wales: retrospective analysis.* BMJ, 2012. **344**: p. e874.
131. Hansson-Lundblad, C., et al., *A small number of older type 2 diabetic patients end up visually impaired despite regular photographic screening and laser treatment for diabetic retinopathy.* Acta Ophthalmologica Scandinavica, 2002. **80**(3): p. 310-5.
132. Agardh, E., et al., *The five-year incidence of blindness after introducing a screening programme for early detection of treatable diabetic retinopathy.* Diabetic Medicine, 1993. **10**(6): p. 555-9.
133. de Fine Olivarius, N., et al., *Prevalence and progression of visual impairment in patients newly diagnosed with clinical type 2 diabetes: a 6-year follow up study.* BMC Public Health, 2011. **11**: p. 80.
134. Ashford, J.W., et al., *Should older adults be screened for dementia?* Alzheimer's & Dementia, 2006. **2**(2): p. 76-85.
135. *Screening*. Stedman's Online Medical Dictionary 2008 [cited 2008 30 November]; Available from: http://www.stedmans.com/section.cfm/45.
136. Last, J.M., *A Dictionary of Epidemiology, Fourth Edition*, ed. J.M. Last, R.A. Spasoff, and S.S. Harris. 2000, New York: Oxford University Press.
137. Loong, T.W., *Understanding sensitivity and specificity with the right side of the brain.* BMJ, 2003. **327**(7417): p. 716-9.
138. British Diabetic Association, *Retinal photographic screening for diabetic eye disease. A British Diabetic Association Report*. 1997, British Diabetic Association: London.
139. *Diabetes Care and Research in Europe: The Saint Vincent Declaration.* Diabetic Medicine, 1990. **7**(4): p. 360.
140. Aiello, L.P., et al., *Diabetic retinopathy.* Diabetes Care, 1998. **21**(1): p. 143-56.
141. Backlund, L.B., et al., *New blindness in diabetes reduced by more than one-third in Stockholm County.* Diabetic Medicine, 1997. **14**(9): p. 732-40.
142. Kristinsson, J.K., et al., *Active prevention in diabetic eye disease. A 4-year follow-up.* Acta Ophthalmologica Scandinavica, 1997. **75**(3): p. 249-54.
143. Hutchinson, A., et al., *Effectiveness of screening and monitoring tests for diabetic retinopathy--a systematic review.* Diabetic Medicine, 2000. **17**(7): p. 495-506.
144. Gillibrand, W., et al., *The English national risk-reduction programme for preservation of sight in diabetes.* Molecular and cellular biochemistry, 2004. **261**(1-2): p. 183-5.
145. Gibbins, R.L., et al., *Practical application of the European Field Guide in screening for diabetic retinopathy by using ophthalmoscopy and 35 mm retinal slides.* Diabetologia, 1998. **41**(1): p. 59-64.
146. Claudi, T., et al., *Diabetesomsorg i norsk allmennpraksis. En tilstandsrapport fra Salten og deler av Rogaland [Diabetic care in Norwegian general practice. A report of current status from Salten and some regions in Rogaland].* Tidsskrift for Den Norske Laegeforening, 1997. **117**(25): p. 3661-4.
147. Saaddine, J.B., et al., *Improvements in diabetes processes of care and intermediate outcomes: United States, 1988-2002.* Annals of Internal Medicine, 2006. **144**(7): p. 465-74.
148. Muller, A., et al., *Changes in eye care utilization following an eye health promotion campaign.* Clinical & Experimental Ophthalmology, 2007. **35**(4): p. 305-9.
149. Schunk, M., et al., *Verbesserungen in der Versorgung von Patienten mit Typ-2-Diabetes? Gepoolte Analyse dreier bevölkerungsbasierter Studien (KORA) in der Region Augsburg*

zwischen 1999 und 2008 [Improvements in type 2 diabetes care? Pooled analysis of survey data in southern Germany (KORA) from 1999-2008]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz, 2011. **54**(11): p. 1187-96.
150. Tapp, R.J., et al., *Diabetes care in an Australian population: frequency of screening examinations for eye and foot complications of diabetes.* Diabetes Care, 2004. **27**(3): p. 688-93.
151. Muller, A., et al., *Factors associated with regular eye examinations in people with diabetes: results from the Victorian Population Health Survey.* Optometry and Vision Science, 2006. **83**(2): p. 96-101.
152. Wilson, A., et al., *Coverage in screening for diabetic retinopathy according to screening provision: results from a national survey in England and Wales.* Diabetic Medicine, 2004. **21**(3): p. 271-8.
153. Claudi, T., et al., *Kvaliteten på diabetesbehandlingen i allmennpraksis [Quality of diabetes care in Norwegian general practice].* Tidsskrift for Den Norske Laegeforening, 2008. **128**(22): p. 2570-4.
154. WHO Consultation, *WHO recommendations on the diagnosis and classification of diabetes mellitus*. 1999.
155. Holmen, J., et al., *The Nord-Trøndelag Health Study 1995-97 (HUNT 2): Objectives, contents, methods and participation.* Norsk Epidemiologi 2003. **13**(1): p. 19-32.
156. Erøy, Å.A., et al., *Forekomst av okulære forandringer hos pasienter med type-2 diabetes*, in *Institutt for optometri og synsvitenskap*. 2005, Høgskolen i Buskerud: Kongsberg.
157. Pearce, N., *Effect measures in prevalence studies.* Environmental Health Perspectives, 2004. **112**(10): p. 1047-50.
158. Landis, J.R. and Koch, G.G., *The measurement of observer agreement for categorical data.* Biometrics, 1977. **33**(1): p. 159-74.
159. Keeffe, J.E., et al., *Utilisation of eye care services by urban and rural Australians.* The British Journal of Ophthalmology, 2002. **86**(1): p. 24-7.
160. Fowles, J.B., et al., *The validity of self-reported diabetes quality of care measures.* The International Journal for Quality in Health Care, 1999. **11**(5): p. 407-12.
161. Harris, B. and Sampson, G., *Gender differences in the utilisation of optometric services in Victoria.* Clinical & Experimental Optometry, 2005. **88**(2): p. 109-12.
162. Bertakis, K.D., et al., *Gender differences in the utilization of health care services.* Journal of Family Practice, 2000. **49**(2): p. 147-52.
163. Nissen, K.R., et al., *The prevalence and incidence of visual impairment of age 20-59 years in industrialized countries: A review.* Ophthalmic Epidemiology, 2003. **10**(4): p. 279-291.
164. Wong, T.Y., et al., *Retinal microvascular abnormalities and their relationship with hypertension, cardiovascular disease, and mortality.* Survey of Ophthalmology, 2001. **46**(1): p. 59-80.
165. Pollack, A.L. and Brodie, S.E., *Diagnostic yield of the routine dilated fundus examination.* Ophthalmology, 1998. **105**(2): p. 382-6.
166. Lash, S.C., *Assessment of information included on the GOS 18 referral form used by optometrists.* Ophthalmic & Physiological Optics, 2003. **23**(1): p. 21-3.
167. Nguyen, T.T. and Wong, T.Y., *Retinal vascular manifestations of metabolic disorders.* Trends in Endocrinology & Metabolism, 2006. **17**(7): p. 262-8.
168. Centers for Disease Control and Prevention, *Correctable visual impairment among persons with diabetes - United States, 1999-2004.* Morbidity and Mortality Weekly Report (MMWR), 2006. **55**(43): p. 1169-72.

Papers and Appendix

I

II

BMC Health Services Research

Research article

Suspected retinopathies in Norwegian optometric practice with emphasis on patients with diabetes: a cross-sectional study

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Published: 8 February 2008

BMC Health Services Research 2008, **8**:38 doi:10.1186/1472-6963-8-38

Received: 19 April 2007
Accepted: 8 February 2008

This article is available from: http://www.biomedcentral.com/1472-6963/8/38

Abstract

Background: The scope of optometry differs worldwide. In Norway the vast majority of optometrists perform ophthalmoscopy as part of their routine examinations. The aim of this study was to describe the frequency of *suspected* retinopathies in patients seen for routine optometric examination and to determine how optometrists deal with these patients.

Methods: 212 optometrists participated in a questionnaire survey and a practice registration during November 2004 – May 2005. In the practice registration, details for 20 consecutive patient encounters were recorded. Data were analysed by chi-square tests and multiple logistic regression.

Results: All optometrist stated that ocular history taking was an integrated part of their routine examination, while general health and diabetes history were routinely addressed by 59% and 42% of the optometrists, respectively. During the practice registration 4,052 patient encounters were recorded. Ophthalmoscopy was performed in 88% of the patients, of which 2% were dilated fundus examinations. Retinopathy was *suspected* in 106 patients, of whom 31 did not report a previous history of ocular or systemic disease. Old age (75+), hypertension and diabetes strongly predicted retinopathy with odds ratio (95% CI) of 6.4 (4.2 to 9.9), 3.8 (2.4 to 6.0) and 2.5 (1.4 to 4.7), respectively. Diabetic retinopathy was seen in 10% of diabetic patients and *suspected* in 0.2% of patients with no established history of diabetes. Retinopathy was not confirmed in 9 out 18 patients with a history of diabetic retinopathy; seven of these had undergone laser treatment. Out of the 106 patients with findings of retinopathy, 28 were referred to an ophthalmologist or a general practitioner (GP), written reports were sent to a GP in 16 cases, ten patients were urged to contact their GP for further follow up, while 52 were considered in need of routine optometric follow up only.

Conclusion: Optometric practice provides a low threshold setting for detecting cases of ocular disease and retinal manifestations of systemic disease in the population. At present diagnosis of retinopathy in Norwegian optometric practice is unreliable. There are potentials for improving the optometrists' routine examination, their patient management patterns and collaboration routines with medical doctors.

Background

The scope of optometry differs worldwide [1] and, more specifically, in Europe [2] ranging from dispensing of optical aids to the diagnosis and treatment of certain ocular diseases. In various countries, there is disparity in the legal recognition of optometry as a health care profession. Since 1988 Norwegian optometric practice has been regulated by The Health Personnel Act, which is founded on the principles of responsible conduct.

In the Scandinavian population, retinal disorders are the most common reason for visual impairment (66%), and in the working age population, diabetes represents a leading cause (13%) [3]. The reported prevalence of diabetic retinopathy differs widely [4]. Most people with diabetes will develop some degree of retinopathy, and 11–30% will develop sight threatening retinopathy during the course of their illness [5-9].

Studies have shown optometrists are able to detect and grade diabetic retinopathy[10] and specially trained optometrist perform well when screening for diabetic retinopathy using dilated, indirect ophthalmoscopy [11-13]. The vast majority of Norwegian optometrists perform ophthalmoscopy as part of their routine examinations [14], and dilated fundus examination can be undertaken by optometrists certified to use ocular diagnostic drugs. Norwegian optometrists with specific certification were given the privilege to acquire and use ocular diagnostic drugs in 2004. At the time of the study 9% of Norwegian optometrists had this privilege, which requires approved education in the use of ocular diagnostic drugs.

There are few studies describing diagnosis and management of retinopathy in routine optometric practice. The aim of this study was to establish the prevalence of possible retinopathy in diabetic and non-diabetic individuals seen in routine optometric practice, to determine the proportion of previously unknown ocular and systemic disease and, finally, to explore how optometrists deal with such patients during everyday practice. The study did not assess or validate the optometrists' findings.

Methods

All members of the Norwegian Association of Optometrists (NAO) working in optometric practice in the community were invited to participate in a questionnaire survey. In addition, 29 practicing non-member optometrists who heard about the study volunteered to participate, making the total sample 790, figure 1. All

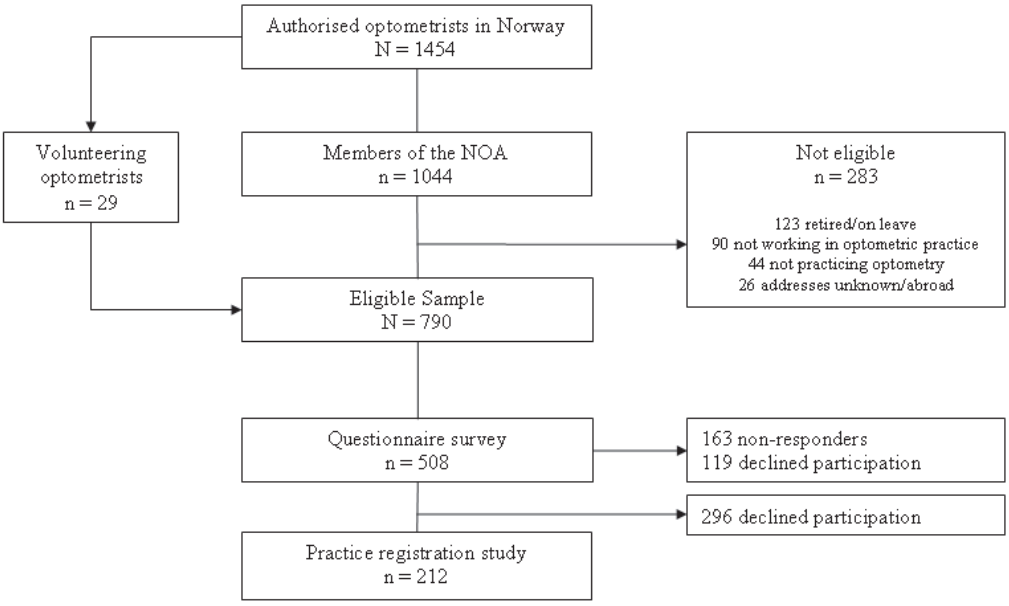

Figure 1
Selection of optometrists in the study.

questionnaire responders (n = 508) were also asked to take part in a practice registration. During November 2004 – May 2005, 212 Norwegian optometrists participated in both the questionnaire survey and the practice registration. The survey has been described elsewhere [14].

In the questionnaire, the optometrists were asked about their education and work experience, practice habits (history taking and examination), opinions on important principles of practice and their collaboration with general practitioners (GPs) and ophthalmologists. In the practice registration, each optometrist recorded the following data for 20 consecutive patients seen for a full eye examination: demographics, patient's history, best corrected visual acuity, intra-ocular pressure, ocular diseases, and how the patients were dealt with (e.g. referral, written report to physicians). Data were reported by the optometrists on a registration form. Recorded ocular diseases were: patient-reported history of cataract, glaucoma and/or age related macular degeneration (AMD) and *suspected* cataract and/or suspected retinopathy. In Norway diagnosis of ocular disease is not in the scope of optometric practice and the terms *suspected* or *possible* retinopathy are used to reflect that these are tentative diagnosis as reported by the optometrists. Additionally patient reported history of: hypertension, cardiovascular disease and diabetes were recorded. In patients with history of diabetes were also asked about type of diabetes, illness duration, treatment, HbA1c-values, blood pressure, diabetic retinopathy, and laser treatment.

The study was presented to Regional Committee for Medical Research Ethics; the study was not regarded subject to specific evaluation and approval. The Norwegian Social Science Data Services were notified prior to commencement of the study. A notice was posted in the consulting room/practice notifying patients of the ongoing practice registration. Patient data was unidentified before it was passed on to the research team and the responding optometrists were anonymous to the researchers.

Differences between proportions were analysed using chi-square tests. Features associated with suspected retinopathy were analysed by univariate and multiple logistic regression. The statistical package SPSS version 12.0.2 was used.

Results

All optometrists reported that a history of vision and ocular health was part of their routine examination. Respectively, 59% and 42% of the optometrists also addressed general health and diabetes in the patient history taking for *all* patients. Ophthalmoscopy was part of the routine examination for the majority of optometrists (96%). One out of four optometrists was qualified to perform dilated fundus examination. Direct ophthalmoscopy was most frequently used (60%). One out of four reported slit lamp indirect ophthalmoscopy as the most frequent method and one out of ten used *both* direct and indirect ophthalmoscopy in most patients.

During the practice registration, 4,052 patient encounters were recorded, 2,216 (57%) with females. The patients' age distribution is shown in figure 2. Among the patients, 166 had a known history of diabetes, 439 had known hypertension, while 125 had some other known cardiovascular disease (hypertension excluded). In patients with a history of diabetes, 34 reported a known history of hypertension and 14 reported a known history of other cardio-vascular disease (hypertension excluded).

Ophthalmoscopy was performed in 3,576 (88%) of the patients, of which 78 (2%) were dilated fundus examinations. In patients with known diabetes, ophthalmoscopy was performed significantly more often than in non-diabetics (96% vs 88%, p = 0.002). Tentative retinopathy was found in 106 (3%) patients, of whom 57 (59%) were females. Almost half of these patients were 75 years or older, and none were younger than 16 years. In patients with diabetes, 35% of the *possible* retinopathies were found in the age group 16–64 years. There were no statistically significant differences with regard to gender, age, and known history of hypertension and/or cardiovascular disease between diabetic and non-diabetic patients with findings of retinopathy.

The most common tentative diagnosis made during fundus examination was macular disease (Table 1). More than half of the patients had no previous history of AMD. Diabetic retinopathy was *suspected* in 23 patients, among whom six had no established history of diabetes and 14 had no previous history of retinopathy. In patients with *suspected* hypertensive/vascular retinopathy, 10 out of 27 had no history of hypertension and/or cardiovascular disease and none had a history of diabetes.

Multiple logistic regression analysis showed that old age (75+), hypertension and diabetes were independent predictors of retinopathy (all kinds), with odds ratio (95% CI) of 6.4 (4.2 to 9.9), 3.8 (2.4 to 6.0) and 2.5 (1.4 to 4.7), respectively. For vascular retinopathy only diabetes and hypertension were independent predictors with odds ratio (95% CI) of 7.2 (3.7 to 14.1) and 4.9 (2.6 to 9.3), respectively.

Diabetic retinopathy was seen in 17 (10%) of the diabetic patients, of these nine had reported history of diabetic retinopathy. However, retinopathy was not described by the optometrists in 9 out of 18 patients with reported his-

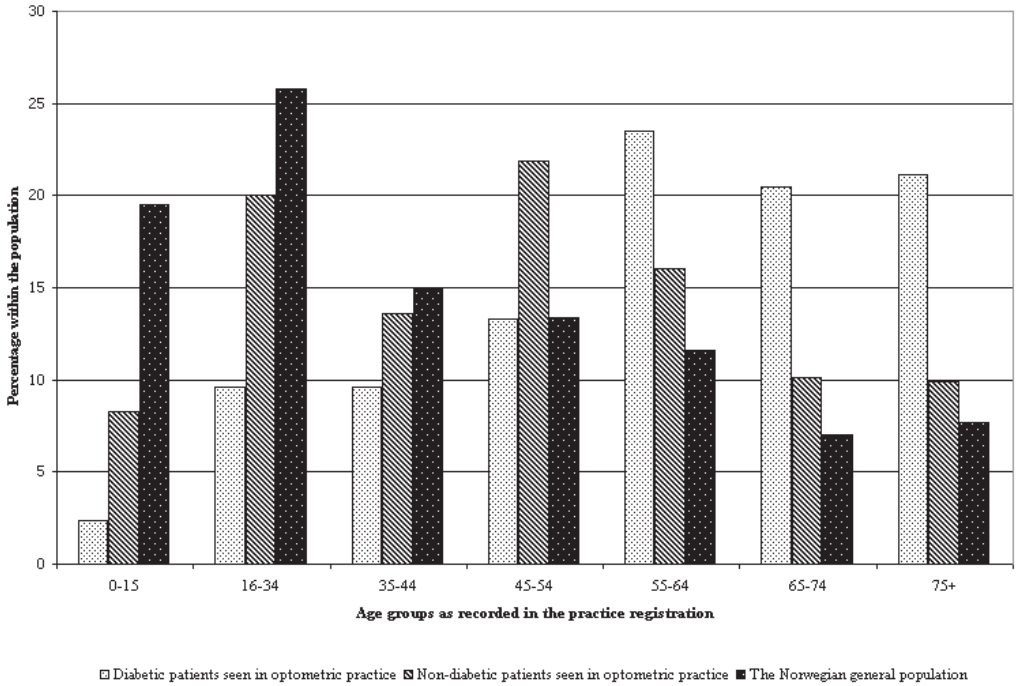

Figure 2

Age distribution of diabetic and non-diabetic patients seen in Norwegian optometric practice compared to the age distribution of the Norwegian population. □ Diabetic patients seen in optometric practice, ▨ Non-diabetic patients seen in optometric practice, ■ The Norwegian population.

Table 1: Clinical findings in 3,576 fundus examined encounters and management* by tentative diagnosis and history.

Optometrists' tentative diagnosis and patients' history	n	Referral/report/patient urged to contact doctor	No/routine optometric follow up
Diabetic retinopathy	**23**	**12**	**11**
No history of retinopathy	14	8	6
History of retinopathy	9	4	5
Hypertensive/vascular retinopathy	**27**	**16**	**11**
No history of retinopathy	26	15	11
History of retinopathy	1	1	
Macular disease†	**56**	**26**	**30**
No history of retinopathy	31	18	13
History of retinopathy	25	8	17
All retinopathies	**106**	**54**	**52**
No retinopathy	**3,470**	**385**	**3,085**

* Fisher's Exact Test $p < 0.001$ between patients with findings of retinopathy and patients with no findings of retinopathy
† Fisher's Exact Test $p = 0.003$ between patients with retinopathy findings and known history of retinopathy and patients with retinopathy findings and no history of retinopathy.

tory of diabetic retinopathy. Seven of these nine patients reported to have undergone laser treatment. There were no significant differences with regard to gender, age, type of diabetes, diabetes treatment, history of hypertension or cardiovascular disease between diabetic patients with findings of retinopathy (n = 17) and diabetic patients with no retinopathy (n = 147).

In total, 439 of the 3,576 (12%) fundus examined patients were judged by the optometrists to be in need of some medical follow up (referral, report or patient consultation) of the ocular findings (Table 1).

Retinopathy was *suspected* in 3% of the patients seen in optometric practice; of whom two thirds had no previous history of retinopathy. More than half of the *suspected* retinopathies were considered to be in need of some further management by a medical practitioner. Patients with retinopathy were more frequently prompted to contact a physician if the retinopathy was previously unknown (41/71 vs. 13/35, p = 0.003). The reason for non-referral of patients with findings of retinopathies was not explored.

Discussion

In our study population, the proportion of vascular retinopathy seen in non-diabetics was lower than expected according to figures reported in epidemiological studies [15]. This could be due to the low frequency of dilated fundus examinations in our study. Dilated indirect ophthalmoscopy and photographic grading have a higher sensitivity than direct ophthalmoscopy in detection of retinal abnormalities[16,17]. The low frequency of dilated fundus examinations in our study can be explained by the small number of optometrist qualified to perform dilated ophthalmoscopy and the recent introduction of the privilege to acquire and use ocular diagnostic drugs.

Reported prevalence of diabetic retinopathy varies widely. In Scandinavia, prevalence between 13.8 and 75.1% have been reported in people with diabetes [4], this is higher than the proportion detected by Norwegian optometrists in their practice. However, we do not know how well diabetic patients seen in optometric practice correspond with the diabetic population in the community. The lower number of retinopathies among diabetics seen in optometric practice may reflect a selection bias; diabetic patients should have their retinas regularly examined by an ophthalmologist according to guidelines [18]. Diabetic patients with retinopathies may therefore be less likely to go to an optometrist.

Nine reported cases of retinopathy were not described by the optometrists; however, most of these patients had undergone laser treatment. A possible explanation may be that scarring from laser treatment has not been regarded as retinopathy by the optometrists. However, the retinopathies not detected by the optometrists and the overall low numbers of retinopathies observed among both non-diabetics and diabetics may also represent a poor diagnostic sensitivity. Unfortunately, our data did not permit us to validate the quality of the optometrists' diagnostic work.

The optometrists' follow-up decisions in patients with findings of retinopathy should raise some concern. Only one quarter of the patients with *suspected* vascular retinopathy and no known history of retinopathy or related systemic disease were only considered to be in need of optometric routine follow up. This practice is probably not acceptable. In general, these patients should be seen by a physician as retinal microvascular changes are related to long-term hypertension, type 2 diabetes, impaired glucose metabolism, obesity, dyslipidemia, stroke and an increased cardiovascular mortality [19]. This may suggest that optometrists make *medical* judgements and that patient management depends on their evaluation of the ocular findings, not solely on the patient's history. However, our numbers are low and the reason for non-referral has not been recorded in the study, the interpretation should therefore be considered with caution. If some optometrists do take inappropriate medical responsibility, one possible explanation could be inadequate report and referral routines and lack of established collaboration with medical practitioners.

Previous studies of optometrist's effectiveness in screening for diabetic retinopathy have revealed a specificity ranging from 62 to 95% and a sensitivity of 70 to 87% [11-13,17] Based on the reported prevalence of diabetic retinopathy in the Norwegian diabetic population (13.8%) [20] and the number of retinopathies missed (n = 9) and detected (n = 17) by the optometrists in this study, we propose that the diagnostic specificity must be high. It is unlikely that report/referral of cases of *suspected* retinopathy will impose undue pressure on the health care services. This is supported by a previous study by Riise et al [21] which concluded that 94% of referrals form Norwegian optometrists were clinically relevant. However, taking the low diagnostic sensitivity into consideration suggests that the routine examination as currently undertaken by Norwegian optometrists is an unreliable method of screening for diabetic retinopathy. Moreover, the study illustrates the disparity of optometric practice in Europe and worldwide with regard to training and the role in the health care system, emphasizing the importance that health policies decisions are founded on the practice in the community were the policy will be employed.

Some limitations of the study should be taken into consideration. First, as compared to the non-participants, the optometrists who took part in this study tended to be

younger, more were females, and they had in general higher education and worked in smaller communities[14]. Hence their frequency of retinal examinations, method of ophthalmoscopy and collaboration habits may differ from that of the non-participants. Second, practice registration data was recorded for consecutive patients to avoid selection bias, however, the reported patient histories relied on patients' self-report and memory recall. Third, the practice registration may have influenced the way the optometrists performed their routine examination. Finally, we did not observe the optometrists' work and their conclusions were not verified.

Conclusion

Optometric practice is a low threshold setting for case-finding of ocular pathology and retinal manifestations of systemic disease in the population. At present, the diagnosis of retinopathies in Norwegian optometric practice is unreliable. There are potentials for improving the optometrists' routine examination, their patient management patterns and collaboration routines with medical doctors.

List of abbreviations used

AMD: Age related macular degeneration; CVD: Cardiovascular disease; GP: General practitioner; HTN: Hypertension; NAO: Norwegian Association of Optometrists.

Competing interests

The authors declare that they have no financial competing interests.

VS is a member of the Norwegian Optometric Associations' board of continuing education and board of optometric rehabilitation.

Authors' contributions

VS conceived of the study and participated in its design, acquisitioned and statistically analysed the data and drafted the manuscript. PG participated in the design of the study and interpretation of data, and helped to draft the manuscript. JS participated in the design of the study and helped to draft the manuscript. RB, LSB and JJ participated in the design of the study and critically revised the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We thank the optometrists participating in the study and Dr. Patricia M. Riddell for helpful comments.

References

1. Di Stefano A: **World optometry: the challenges of leadership for the new millennium.** *Optometry* 2002, **73(6):**339-350.
2. Hamakiotes DS, Thal LS: **The unification of European optometry: how the profession will change after 1992.** *J Am Optom Assoc* 1991, **62(12):**904-913.
3. Buch H, Vinding T, La Cour M, Appleyard M, Jensen GB, Nielsen NV: **Prevalence and causes of visual impairment and blindness among 9980 Scandinavian adults: the Copenhagen City Eye Study.** *Ophthalmology* 2004, **111(1):**53-61.
4. Williams R, Airey M, Baxter H, Forrester J, Kennedy-Martin T, Girach A: **Epidemiology of diabetic retinopathy and macular oedema: a systematic review.** *Eye* 2004, **18(10):**963-983.
5. Younis N, Broadbent DM, Harding SP, Vora JR: **Prevalence of diabetic eye disease in patients entering a systematic primary care-based eye screening programme.** *Diabet Med* 2002, **19(12):**1014-1021.
6. Skrivarhaug T, Fosmark DS, Stene LC, Bangstad HJ, Sandvik L, Hanssen KF, Joner G: **Low cumulative incidence of proliferative retinopathy in childhood-onset type 1 diabetes: a 24-year follow-up study.** *Diabetologia* 2006, **49(10):**2281-2290.
7. Nordwall M, Bojestig M, Arnqvist HJ, Ludvigsson J: **Declining incidence of severe retinopathy and persisting decrease of nephropathy in an unselected population of Type 1 diabetes-the Linkoping Diabetes Complications Study.** *Diabetologia* 2004, **47(7):**1266-1272.
8. Hovind P, Tarnow L, Rossing K, Rossing P, Eising S, Larsen N, Binder C, Parving HH: **Decreasing incidence of severe diabetic microangiopathy in type 1 diabetes.** *Diabetes Care* 2003, **26(4):**1258-1264.
9. Henricsson M, Nystrom L, Blohme G, Ostman J, Kullberg C, Svensson M, Scholin A, Arnqvist HJ, Bjork E, Bolinder J, Eriksson JW, Sundkvist G: **The incidence of retinopathy 10 years after diagnosis in young adult people with diabetes: results from the nationwide population-based Diabetes Incidence Study in Sweden (DISS).** *Diabetes Care* 2003, **26(2):**349-354.
10. Schmid KL, Swann PG, Pedersen C, Schmid LM: **The detection of diabetic retinopathy by Australian optometrists.** *Clin Exp Optom* 2002, **85(4):**221-228.
11. Olson JA, Strachan FM, Hipwell JH, Goatman KA, McHardy KC, Forrester JV, Sharp PF: **A comparative evaluation of digital imaging, retinal photography and optometrist examination in screening for diabetic retinopathy.** *Diabet Med* 2003, **20(7):**528-534.
12. Hulme SA, Tin UA, Hardy KJ, Joyce PW: **Evaluation of a district-wide screening programme for diabetic retinopathy utilizing trained optometrists using slit-lamp and Volk lenses.** *Diabet Med* 2002, **19(9):**741-745.
13. Prasad S, Kamath GG, Jones K, Clearkin LG, Phillips RP: **Effectiveness of optometrist screening for diabetic retinopathy using slit-lamp biomicroscopy.** *Eye* 2001, **15(Pt 5):**595-601.
14. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Optometric practice in Norway: a cross-sectional nationwide study.** *Acta Ophthalmol Scand* 2007, **85(6):**671-676.
15. Wong TY, Klein R, Klein BE, Tielsch JM, Hubbard L, Nieto FJ: **Retinal microvascular abnormalities and their relationship with hypertension, cardiovascular disease, and mortality.** *Surv Ophthalmol* 2001, **46(1):**59-80.
16. Pollack AL, Brodie SE: **Diagnostic yield of the routine dilated fundus examination.** *Ophthalmology* 1998, **105(2):**382-386.
17. Hutchinson A, McIntosh A, Peters J, O'Keeffe C, Khunti K, Baker R, Booth A: **Effectiveness of screening and monitoring tests for diabetic retinopathy--a systematic review.** *Diabet Med* 2000, **17(7):**495-506.
18. Claudi T, Cooper JG, Midthjell K, Daae C, Furuseth K, Hanssen KF: **NSAMs handlingsprogram for diabetes i allmennpraksis 2005. Kortversjon [NSAMs guidelines for diabetes in general practice 2005. Short version] In Norwegian.** Norsk selskap for allmennmedisin, Den norske Lægeforening, Norges Diabetesforbund; 2005.
19. Nguyen TT, Wong TY: **Retinal vascular manifestations of metabolic disorders.** *Trends Endocrinol Metab* 2006, **17(7):**262-268.
20. Hapnes R, Bergrem H: **Diabetic eye complications in a medium sized municipality in southwest Norway.** *Acta Ophthalmol Scand* 1996, **74(5):**497-500.
21. Riise D, Arnestad JE, Saetrom KM: **Bør optikere kunne henvise pasienter til øyelege? [Should optometrists be able to refer patients to ophthalmologists?] In Norwegian, summary in English.** *Tidsskr Nor Laegeforen* 2000, **120(18):**2113-2114.

Pre-publication history
The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1472-6963/8/38/prepub

III

BMC Health Services Research

Research article

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Care of vision and ocular health in diabetic members of a national diabetes organization: a cross-sectional study

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Published: 28 July 2008

BMC Health Services Research 2008, **8**:159 doi:10.1186/1472-6963-8-159

Received: 25 February 2008
Accepted: 28 July 2008

This article is available from: http://www.biomedcentral.com/1472-6963/8/159

Abstract

Background: Regular examination and early treatment of diabetic retinopathy can prevent visual loss. The aim of the study was to describe the care of vision and ocular health in people with diabetes in Norway.

Methods: A cross-sectional questionnaire survey of a random sample (n = 1,887) of the Norwegian Diabetic Associations' (NDA) members was carried out in 2005. Questions were asked about care of vision and ocular health, history of ocular disease and visual symptoms, general medical history and diabetes management. The study was approved by the Regional Committee for Medical Research Ethics.

Results: The response rate was 74%. Forty-four questionnaires with incomplete data regarding gender, age or type of diabetes were excluded, leaving 1352 cases (52% females) for analysis. 451 (33%) had type 1 and 901 (67%) had type 2 diabetes, the mean duration of diabetes was respectively, 22 (sd ± 14) and 10 (sd ± 9) years. In all 1,052 (78%) had their eyes examined according to guidelines and 1,169 (87%) confirmed to have received information about regular eye examinations. One in two recalled to have received such information from their general practitioner. To have received information about the importance of eye examinations (PR 3.1, 95% CI 2.4 to 4.0), and diabetes duration > 10 years (PR 1.2, 95% CI 1.2 to 1.3), were independently associated with reporting regular eye examinations. A history of diabetic retinopathy was reported by 178 (13%) responders, of which 101 (57%) reported a history of laser treatment. Responders who had regular eye examinations reported more frequently a history of diabetic retinopathy (19% vs. 5%, $p < 0.001$). The frequency of retinopathy was significantly higher in responders with reported HbA1c values above treatment target (23% vs. 13%, $p = 0.001$). However, in responders who were not regularly examined, there was no difference in reported frequency of retinopathy with regard to HbA1c level.

Conclusion: Eight out of ten diabetic members of the NDA had their eyes examined according to current guidelines and the majority was well informed about the risk of vision loss due to diabetes. The results indicate that the reported history of diabetic retinopathy likely underestimates the prevalence of retinopathy.

Background

In Western societies, diabetic retinopathy is one of the leading causes of visual impairment and blindness in the working age group [1-3]. The prevalence of diabetic retinopathy in Norway is sparsely described in the literature [4,5]. It is estimated that 90–120,000 Norwegians have known diabetes and that probably just as many have undiagnosed diabetes [6]. Most diabetic patients will develop some degree of retinopathy. Studies indicate that between 6% and 30% will develop sight threatening retinopathy during the course of their illness [7-14]. In Western Europe, diabetic retinopathy accounts for 4.7–13.3% of the blind and partial sight registrations [3,15-17]. Regular examination of ocular health and early treatment of diabetic retinopathy can prevent most cases of visual loss [18-22], and ophthalmologic screening of patients with diabetes is more cost-effective than many other health interventions for detecting and treating disease [21,23]. The Norwegian College of General Practitioners has published guidelines for examination of ocular health in patients with diabetes, first issued in 1988 [24]. Table 1 shows the Norwegian practice guidelines compared to practice guidelines in the United Kingdom, USA and Australia. In 1996 only 53% of diabetic patients seen in general practice were managed according to these guidelines [25,26].

The aim of this study was to describe and analyse the care of vision and ocular health among people with diabetes in Norway. Secondly, we wanted to explore their sources of information regarding ocular care. Finally we liked to assess the reported care in relation to established practice guidelines and to identify features associated with good practice.

Methods

The study had a cross-sectional design. A random sample of persons with diabetes, drawn from the member list of the Norwegian Diabetes Association (NDA), was invited to participate in a questionnaire survey. At the time of the study, NDA was the only national registry of adults with diabetes. NDA is a voluntary, independent organization with the objective of serving people with diabetes and others who have an interest in diabetes. In 2005 NDA had 35,058 members, including mainly people with diabetes, some of their relatives (about 900), and around 3,000 health care professionals. The type of diabetes was not recorded in the NDA membership registry. A random sample comprising about 6% of NDA members 18 years and older was drawn by computer from the NDA membership registry. They were subsequently sent a postal questionnaire in October-December 2005. Non-diabetics, deceased members and members with unknown address or living abroad were excluded, leaving an eligible sample of 1,887. Information about the study, the voluntary nature of participation, confidentiality and study approval were given on the front page of the questionnaire and the return of a completed questionnaire was regarded as written consent. Reminders were sent once to all participants. The questionnaire had been assessed in a pilot survey. This pilot survey led to the inclusion of a question regarding source of information about the importance of regular eye examinations. The questionnaire included questions about care of vision and ocular health, history of ocular disease and visual symptoms, as well as details about type of diabetes, year of diagnosis, treatment, blood glucose stability, most recently recorded HbA1c and blood pressure, antihypertensive and cholesterol lowering medication, and current and previous

Table 1: Practice guidelines for HbA1c treatment target and management of ocular health in patients with diabetes.

	Norway*	United Kingdom†	USA‡	Australia§
HbA1c treatment target				
Children/Type 1 < 18 years		< 7.5%	< 7%	
Type 1 > 18 years		< 7.5%	< 7%	
Type 2		6.5–7.5%	< 7%	
Younger (<80 years)	< 7%		< 7%	
Older (>80 years)	< 9%		< 7%	
Screening for diabetic retinopathy				
First examination				
Children/Type 1<18 years		At age 12 years		At puberty
< 30 years/Type 1	5 years after diagnosis	At diagnosis	5 years after diagnosis	At diagnosis
> 30 years/Type 2	At diagnosis	At diagnosis	At diagnosis	At diagnosis
Follow-up in absence of retinopathy				
Children/Type 1 < 18 years		Annually	Annually	At least biannually
< 30 years/Type 1	Annually	Annually	Annually	At least biannually
> 30 years/Type 2	Annually/Biannually	Annually	Annually	At least biannually
Follow-up in retinopathy	Individual	Individual	Individual	Individual

Norwegian practice guidelines compared to practice guidelines in the United Kingdom, USA and Australia at the time (2005) of the study.
*The Norwegian College of General Practitioners, †National Institute for Clinical Excellence, ‡American Diabetes Association, §National Health and Medical Research Council

smoking. In the questionnaire, regular examination was defined as examination at regular intervals, e.g. yearly, every six months or monthly. Furthermore, eye examination and vision examination was defined as examination of the back of the eye/retina and examination of sight, respectively. The specific questions on eye examination were: "Do you have your eyes regularly examined due to your diabetes?" and "In general, how long time is it between the eye examinations?".

In 2001 a list system was implemented in Norwegian general medical practice, implying that all citizens were listed with one particular general practitioner (GP). In this system the GP has the primary responsibility for the management and follow-up of patients with diabetes. Referral to a specialist (ophthalmologist) must be made by a GP. The Norwegian College of General Practitioners guidelines [26] were used as standard of patient care for comparison with reported care (Table 1).

Data analysis was performed with the statistical package SPSS version 13.0. Questionnaires with missing data for gender, age or type of diabetes, or diabetes other than type 1 and type 2 (3%) were excluded from analysis. The data were analysed in frequency and summation tables; group differences were analysed using student-t, chi-square and Fisher's exact tests. A p-value < 0.01 was considered statistically significant. Features associated with known history of diabetic retinopathy, visual symptoms, regular follow up and lack of eye examination were analysed by univariate and multiple logistic regression. Variables with $p \leq 0.25$ from the univariate analyses were entered into the logistic regression models. Additionally, the prevalence rate ratios (PR) were calculated for features associated with regular eye examination and history of diabetic retinopathy to provide a natural intelligible effect measure and to allow for comparison to the prevalence odds ratios (POR).

Data were collected anonymously and the study was approved by the Regional Committee for Medical Research Ethics.

Results

The total number of responders was 1,396 (74%). Forty-four questionnaires had missing information regarding either age, gender, type of diabetes or diabetes other than type 1 and type 2. The study is based on the remaining 1,352 cases, 699 (52%) were females. In all, 451 (33%) responders had type 1 diabetes and 901 (67%) had type 2 diabetes. Table 2 shows basic demographic and medical data of the responders.

In all, 1,141 (85%) of the responders had their eyes regularly examined. Of these 1,052 (92%) were examined according to recommended follow up schedule. Only 6% reported never to have had their eyes examined. In persons with type 1 diabetes, 88% (358/407) were examined annually or more frequently: respectively 2%, 15%, 3% and 69% were examined every 1–3 months, 4–6 months, 7–9 months and 10–12 months. In persons with type 2 diabetes, 98% (694/711) were examined biannually or more frequently: respectively 2%, 13%, 1%, 63% and 18% were examined every 1–3 months, 4–6 months, 7–9 months, 10–12 months and 12–24 months. The time of the first examination was in accordance to guidelines in 31% of responders with type 1 diabetes and in 47% of responders with type 2 diabetes (Table 3). For all responders, the median interval between eye examinations was 12 months (65%). Eight-teen percent were regularly examined more frequently. In total, 1,169 (87%) responders confirmed to have received some information about the importance of having their eyes regularly examined due to their diabetes. Responders who had their eyes examined according to guidelines were more than twice as likely to have received such information than responders who did not undergo regular eye examinations (95% vs. 42%, $p < 0.001$). Having received information about the importance of eye examinations, and diabetes duration of more than 10 years, were both independently associated with regular eye examinations (Table 4).

Spectacles and/or contact lenses were used by 1,188 (88%) of the responders. The vision was regularly examined in 1,045 of the responders who used optical correction. This was significantly more frequent than among responders who did not use optical correction (88% vs. 71%, $p < 0.001$). However, there was no significant difference in the frequency of eye examinations between the groups. During the previous year, 611 (45%) of the responders had experienced some kind of visual problems. Nearly two in five reported to be helped by optical correction.

Visual problems due to diabetes were reported by 156 (12%) responders. A history of laser treatment of ocular disease related to diabetes was reported by 81% of the responders with visual problems related to diabetes and known history of diabetic retinopathy. In all, 178 (13%) reported a history of diabetic retinopathy, of these 101 (57%) also reported a history of laser treatment. Diabetic retinopathy was associated with type 2 diabetes, diabetes duration >10 years, use of oral anti-diabetic agents, use of insulin, HbA1c above 7%, unstable blood glucose levels and the use of anti-hypertensive medication. In a multivariate logistic regression analysis diabetes duration was the only reported factor independently associated with a history of diabetic retinopathy. The prevalence of diabetic retinopathy was higher in patients with diabetes duration longer than 10 years, than in patients with shorter disease

Table 2: Demographic and medical characteristics of responders with type 1 and type 2 diabetes (n = 1,352), n (%)

	All patients (n = 1,352)	Type 1 (n = 451)	Type 2 (n = 901)
Sex distribution			
Female	699 (51.7)	247 (54.8)	452 (50.2)
Male	653 (48.3)	204 (45.2)	449 (49.8)
Age distribution*			
< 20 years	7 (0.5)	6 (1.3)	1 (0.1)
21–30 years	55 (4.1)	54 (12.0)	1 (0.1)
31–40 years	108 (8.0)	87 (19.3)	21 (2.3)
41–50 years	185 (13.7)	106 (23.5)	79 (8.8)
51–60 years	315 (23.3)	91 (20.2)	224 (24.9)
61–70 years	349 (25.8)	71 (15.7)	278 (30.9)
71–80 years	261 (19.3)	30 (6.7)	231 (25.6)
81–90 years	72 (5.3)	6 (1.3)	66 (7.3)
Mean age (sd)	59 (± 15)	48 (± 15)	64 (± 11)
Mean duration of diabetes (sd)‡	14 (± 12)	22 (± 14)	10 (± 9)
Mean HbA1c at last diabetes follow up (sd)§	7.3 (± 1.2)	7.5 (± 1.0)	7.1 (± 1.3)
HbA1c within guideline treatment target*,§			
All patients (HbA1c <7%/<9% depending on age)	461 (41.2)	107 (26.4)	354 (49.6)
Patients = 80 years (HbA1c <7%)	420 (39.1)	103 (25.6)	317 (47.2)
Patients > 80 years (HbA1c <9%)	41 (87.2)	4 (100)	37 (86.0)
Stable blood glucose level previous year∥	845 (63.9)	258 (58.6)	587 (66.6)
Diabetes treatment*			
Diet (n = 757)	668 (88.2)	129 (66.2)	539 (95.9)
Exercise (n = 657)	536 (81.6)	112 (59.6)	424 (90.4)
Weight reduction (n = 430)	197 (45.8)	16 (10.4)	181 (65.6)
Oral medication (n = 771)	564 (73.2)	16 (10.3)	548 (89.1)
Insulin (n = 896)	742 (82.8)	443 (99.8)	299 (66.2)
Blood pressure and cholesterol medication*			
Blood pressure (n = 1,337)	687 (51.4)	142 (31.6)	545 (61.4)
Cholesterol (n = 1,324)	591 (44.6)	123 (27.7)	468 (53.2)
Smoking			
Present smoker† (n = 1,345)	203 (15.1)	88 (19.6)	115 (12.8)
Previous smoker (n = 1,306)	716 (54.8)	216 (50.2)	500 (57.1)
Known history of ocular disease			
Cataract* (n = 1,019)	261 (25.6)	63 (17.2)	198 (30.4)
Diabetic retinopathy* (n = 1,058)	182 (17.2)	91 (23.3)	91 (13.6)
Glaucoma* (n = 905)	93 (10.3)	14 (4.2)	79 (13.8)
Age-related macula degeneration† (n = 857)	35 (4.1)	6 (1.9)	29 (5.4)
Hypertensive/occlusive vascular retinopathy (n = 851)	19 (2.2)	3 (0.9)	16 (3.0)
Laser treated diabetes related ocular disease¶			
History of diabetic retinopathy reported	105 (10.0)	57 (14.7)	48 (7.2)
History of diabetic retinopathy not reported*	19 (1.8)	7 (1.8)	12 (1.8)

Pearson chi-square *p < 0.001 and †p < 0.01 between type 1 and type 2 diabetics.
Data missing for ‡31,§ 232, ∥30 and ¶300 responders

duration prevalence ratio (95% CI) of 3.5 (2.5 to 5). Moreover, a history of diabetic retinopathy was more frequently reported by responders who had their eyes regularly examined (Table 5).

Discussion

The vast majority of persons with diabetes responding to this survey had their eyes examined according to guidelines advised by the Norwegian College of General Practitioners [26], Table 1. Diabetes duration and having received information about potential eye complications were independently associated with eye care management according to the guidelines.

Compared to cross-sectional surveys of the general diabetic population in UK, Australia and the United States [27-30] the number of persons with diabetes who had their eyes examined according to guidelines was equal or higher in our study. Furthermore, the proportion who had been examined according to guidelines (78%) were noticeably higher than (53%) reported in a previous Norwegian survey from 1996 [25]. Our study may reflect an actual improvement in the management of ocular care in

Table 3: Information about eye examination and frequency of eye and vision examination (n = 1,352), n (%)

	All patients (n = 1,352)		Type 1 (n = 451)		Type 2 (n = 901)	
Informed about the importance of eye examination*/‡,§	**1,169**	**(86.8)**	**433**	**(96.2)**	**736**	**(82.1)**
Source of information not mutually exclusive*						
General practitioner§	678	(58.0)	205	(47.3)	473	(64.3)
Ophthalmologist	515	(44.1)	202	(46.7)	313	(42.5)
Hospital§	338	(28.9)	224	(51.7)	114	(15.5)
Other medical practitioner§	114	(9.8)	95	(21.9)	19	(2.6)
Optometrist	93	(8.0)	41	(9.5)	52	(7.1)
Leaflets/Journal of the Norwegian Diabetes Association∥,§	298	(25.5)	136	(31.4)	162	(22.0)
Diabetes patient education course	218	(18.6)	77	(17.8)	218	(18.6)
Media	68	(5.8)	24	(5.5)	44	(6.0)
Other persons with diabetes§	94	(8.0)	47	(10.9)	47	(6.4)
First eye examination after diagnosis†,§						
Within 1 year	538	(40.3)	121	(26.9)	417	(47.1)
Within 1–5 years	433	(32.5)	138	(30.7)	295	(33.3)
After more than 5 years	221	(16.6)	140	(31.2)	81	(9.2)
Never examined	74	(5.5)	6	(1.3)	68	(7.7)
Unsure	68	(5.1)	44	(9.8)	24	(2.7)
Regular eye examination reported by one or more methods‡,§						
Eye examination by one or more methods	1,141	(85.4)	416	(92.7)	725	(81.7)
Examination by ophthalmologist	965	(84.6)	339	(81.5)	626	(86.3)
Fundusphotography	443	(38.8)	202	(48.6)	241	(33.2)
Examination by optometrist	90	(7.9)	30	(7.2)	60	(8.3)
Examination by general practitioner	21	(1.8)	6	(1.4)	15	(2.1)
Regular vision examination reported by one or more methods						
by one or more methods	1,161	(85.9)	386	(85.6)	775	(86.0)
by ophthalmologist	979	(84.3)	330	(85.5)	649	(83.7)
by optometrist	252	(21.7)	84	(21.8)	168	(21.7)
by other health care provider	33	(2.8)	18	(4.7)	15	(1.9)
by medical doctor	29	(2.5)	8	(2.1)	21	(2.7)

Missing data for *5,†18, ‡16 responders.
Pearson chi-square § $p < 0.001$ between type 1 and type 2 diabetics.
∥ Journal of the Norwegian Diabetes Association

people with diabetes in Norway. Improved eye care in people with diabetes has also been reported in the United States (1988–2002) and Australia (2003–2005) [28,31]. Unpublished data from a study undertaken in Norwegian general practice in 1999/2000 revealed that three out of four patients with diabetes were managed according to current guidelines (Tor Claudi 2007, personal communication), indicating an improvement of care compared to 1996 [25]. The improved care could be explained by increased focus on diabetes as a modern epidemic,

Table 4: Characteristics associated with regular eye examination in patients with diabetes

Characteristic (association)	Eye exam (%) in group with characteristic	Eye exam (%) in group without characteristic	Crude prevalence ratio (95% CI)	Crude odds ratio (95% CI)	Adjusted* odds ratio (95% CI)	P value*
Information on eye examination	93.0	29.7	3.1 (2.4 to 4.0)	31.5 (20.7 to 48.1)	27.4 (16.7 to 44.8)	<0.001
Diabetes duration > 10 years	93.5	75.0	1.2 (1.2 to 1.3)	4.8 (3.4 to 6.8)	3.1 (2.0 to 5.1)	<0.001
Visual problems related to diabetes	97.4	84.5	1.6 (1.1 to 1.2)	6.9 (2.5 to 19.1)	3.6 (1.2 to 10.6)	0.024
Using one or more optical corrections	85.9	81.5	1.1 (1.0 to 1.1)	1.4 (0.5 to 1.1)	1.5 (0.8 to 2.9)	0.234
Type of diabetes (Type 1)	92.7	81.7	1.1 (1.1 to 1.2)	0.3 (0.2 to 0.5)	0.9 (0.5 to 1.7)	0.842

*Multivariate logistic regression analysis

Table 5: History of diabetic retinopathy as reported by diabetic patients (n = 900) by blood glucose level* and eye examination, n (%)

	Known history of diabetic retinopathy	No history of diabetic retinopathy
Regular eye examination†		
HbA1c within treatment target	39 (12.9)	264 (87.1)
HbA1c above treatment target	113 (23.3)	371 (76.7)
No regular eye examination		
HbA1c within treatment target	3 (5.5)	52 (94.5)
HbA1c above treatment target	3 (5.3)	54 (94.7)

*HbA1c in accordance with treatment target level given in the Norwegian College of General Practitioners' guidelines.
† Pearson chi-square p = 0.001 between persons with HbA1c within and person with HbA1c above treatment target.

increased professional knowledge about clinical guidelines, increased patient knowledge, and the coverage of diabetes in mass media. However, the observation may also to some extent reflect selection; the responders in our study were members of the NDA and their rate of regular eye examination is probably higher than in the general diabetic population due to a higher interest in own health and more exposure to patient education materials. Moreover, the overrepresentation of persons with type 1 diabetes and persons with long term illness are probably other important explanations for the high compliance with the screening programme. Additionally, self-reports may overestimate the frequency of eye examinations due to recall bias, telescoping and social acceptance[32].

Utilization of eye care services is associated with the uses of health services in general, and with health promotion campaigns [27,29,31]. The fact that half of the patients had not received information about the importance of regular eye examinations by their GP and that not all patients had their eyes examined according to practice guidelines, suggest that there are still potentials for improving the quality of care. Almost 90% of the responders in our study used some form of optical correction and diabetic patients are frequently seen in Norwegian optometric practice [33]. This suggests a role for optometrists in promoting regular eye examinations in diabetes patients. Moreover, the quality of ocular care can probably be improved by strengthening the optometrist-GP communication ensuring that optometrists regularly inform the GP about significant ocular findings (e.g. retinopathy in patients with diabetes) and also about patients who are not regularly examined. This could be achieved through continuing education of Norwegian optometrists and professional awareness campaigns.

The prevalence of known history of diabetic retinopathy among the responders corresponds with the total prevalence of diabetic retinopathy reported in a small Norwegian community, the Eigersund study [4]. However, it is lower than the reported prevalence in recent Danish studies [34,35]. On the other hand, the rate of responders with a history of laser treatment of ocular complications due to diabetes (three out of five) corresponds well with the figures in the Danish studies. The Danish studies are based on clinical examination rather than on self-reports. If we assume corresponding criteria for laser treatment in Norway and Denmark, this suggests an underestimation of the prevalence of diabetic retinopathy in our sample, maybe due to lack of knowledge about the presence of non-sight-threatening diabetic retinopathy among responders.

Tight control of blood glucose and blood pressure reduces the risk of progression towards sight threatening disease [36] and visual outcome in patients with diabetes is related to regular eye examination [22]. In our study, the rate of established diabetic retinopathy was four times higher in responders who had their eyes regularly examined as compared to those who did not attend regular eye examinations. Among responders who had their eyes regularly examined, the frequency of retinopathy was nearly twice as high among those who reported HbA1c values above treatment target. In responders who did not have their eyes regularly examined, however, the reported frequency of retinopathy was the same for both patients with HbA1c above and within treatment target. This further adds to the assumption of a probable underestimation of diabetic retinopathy in our population, not only due to lack of patient knowledge, but also due to lack of regular eye examinations.

The relatively high response rate implies that our findings are representative for diabetes members of the NDA. An important limitation is that the findings from this NDA membership survey cannot be directly extrapolated to the general diabetes population in Norway. The probable underestimation of diabetic retinopathy prevalence even in this patient group, may suggest that the underrecognition may be even larger in the general diabetes population. However, we did not verify whether the reported eye examination and medical history corresponded with medical records.

Conclusion

The majority of diabetic members of NDA has their eyes examined according to existing guidelines and are well aware of the risk of vision loss due to diabetes. The

reported prevalence of diabetic retinopathy is probably underestimated due to lack of knowledge about established retinopathy and undiagnosed diabetic retinopathy among the responders indicating a potential for improvement in care.

Competing interests

The authors declare that they have no financial competing interests.

VS is a board member of the Norwegian Optometric Association and member of Norwegian Optometric Associations' board of continuing education.

Authors' contributions

VS conceived of the study and participated in its design, acquired and statistically analysed the data and drafted the manuscript. PG helped designing the study, supervised the statistical and epidemiological analyses and scrutinized the manuscript for important intellectual content. JJ and JS participated in the design of the study and critically revised the manuscript. All authors read and approved the final manuscript.

Acknowledgements

We thank the responders in the study and the Norwegian Diabetes Association.

References

1. Porta M, Bandello F: **Diabetic retinopathyA clinical update.** *Diabetologia* 2002, **45(12):**1617-1634.
2. Buch H, Vinding T, La Cour M, Appleyard M, Jensen GB, Nielsen NV: **Prevalence and causes of visual impairment and blindness among 9980 Scandinavian adults: the Copenhagen City Eye Study.** *Ophthalmology* 2004, **111(1):**53-61.
3. Bamashmus MA, Matlhaga B, Dutton GN: **Causes of blindness and visual impairment in the West of Scotland.** *Eye* 2004, **18(3):**257-261.
4. Hapnes R, Bergrem H: **Diabetic eye complications in a medium sized municipality in southwest Norway.** *Acta Ophthalmol Scand* 1996, **74(5):**497-500.
5. Joner G, Brinchmann-Hansen O, Torres CG, Hanssen KF: **A nationwide cross-sectional study of retinopathy and microalbuminuria in young Norwegian type 1 (insulin-dependent) diabetic patients.** *Diabetologia* 1992, **35(11):**1049-1054.
6. Stene LC, Midthjell K, Jenum AK, Skeie S, Birkeland KI, Lund E, Joner G, Tell GS, Schirmer H: **[Prevalence of diabetes mellitus in Norway.].** *Tidsskr Nor Laegeforen* 2004, **124(11):**1511-1514.
7. Younis N, Broadbent DM, Harding SP, Vora JR: **Prevalence of diabetic eye disease in patients entering a systematic primary care-based eye screening programme.** *Diabet Med* 2002, **19(12):**1014-1021.
8. Skrivarhaug T, Fosmark DS, Stene LC, Bangstad HJ, Sandvik L, Hanssen KF, Joner G: **Low cumulative incidence of proliferative retinopathy in childhood-onset type 1 diabetes: a 24-year follow-up study.** *Diabetologia* 2006, **49(10):**2281-2290.
9. Nordwall M, Bojestig M, Arnqvist HJ, Ludvigsson J: **Declining incidence of severe retinopathy and persisting decrease of nephropathy in an unselected population of Type 1 diabetes-the Linkoping Diabetes Complications Study.** *Diabetologia* 2004, **47(7):**1266-1272.
10. Hovind P, Tarnow L, Rossing K, Rossing P, Eising S, Larsen N, Binder C, Parving HH: **Decreasing incidence of severe diabetic microangiopathy in type 1 diabetes.** *Diabetes Care* 2003, **26(4):**1258-1264.
11. Henricsson M, Nystrom L, Blohme G, Ostman J, Kullberg C, Svensson M, Scholin A, Arnqvist HJ, Bjork E, Bolinder J, Eriksson JW, Sundkvist G: **The incidence of retinopathy 10 years after diagnosis in young adult people with diabetes: results from the nationwide population-based Diabetes Incidence Study in Sweden (DISS).** *Diabetes Care* 2003, **26(2):**349-354.
12. Cikamatana L, Mitchell P, Rochtchina E, Foran S, Wang JJ: **Five-year incidence and progression of diabetic retinopathy in a defined older population: the Blue Mountains Eye Study.** *Eye* 2007, **21(4):**465-471.
13. Younis N, Broadbent DM, Vora JP, Harding SP: **Incidence of sight-threatening retinopathy in patients with type 2 diabetes in the Liverpool Diabetic Eye Study: a cohort study.** *Lancet* 2003, **361(9353):**195-200.
14. Stratton IM, Kohner EM, Aldington SJ, Turner RC, Holman RR, Manley SE, Matthews DR: **UKPDS 50: risk factors for incidence and progression of retinopathy in Type II diabetes over 6 years from diagnosis.** *Diabetologia* 2001, **44(2):**156-163.
15. Bunce C, Wormald R: **Leading causes of certification for blindness and partial sight in England & Wales.** *BMC Public Health* 2006, **6:**58.
16. Kelliher C, Kenny D, O'Brien C: **Trends in blind registration in the adult population of the Republic of Ireland 1996-2003.** *Br J Ophthalmol* 2006, **90(3):**367-371.
17. Rohrschneider K, Greim S: **[Epidemiology of blindness in Baden, Germany].** *Klin Monatsbl Augenheilkd* 2004, **221(2):**116-121.
18. Aiello LP, Gardner TW, King GL, Blankenship G, Cavallerano JD, Ferris FL 3rd, Klein R: **Diabetic retinopathy.** *Diabetes Care* 1998, **21(1):**143-156.
19. Backlund LB, Algvere PV, Rosenqvist U: **New blindness in diabetes reduced by more than one-third in Stockholm County.** *Diabet Med* 1997, **14(9):**732-740.
20. Kristinsson JK, Hauksdottir H, Stefansson E, Jonasson F, Gislason I: **Active prevention in diabetic eye disease. A 4-year follow-up.** *Acta Ophthalmol Scand* 1997, **75(3):**249-254.
21. Stefansson E, Bek T, Porta M, Larsen N, Kristinsson JK, Agardh E: **Screening and prevention of diabetic blindness.** *Acta Ophthalmol Scand* 2000, **78(4):**374-385.
22. Zoega GM, Gunnarsdottir T, Bjornsdottir S, Hreietharsson AB, Viggosson G, Stefansson E: **Screening compliance and visual outcome in diabetes.** *Acta Ophthalmol Scand* 2005, **83(6):**687-690.
23. Javitt JC, Aiello LP: **Cost-effectiveness of detecting and treating diabetic retinopathy.** *Ann Intern Med* 1996, **124(1 Pt 2):**164-169.
24. Claudi T, Cooper JG, Midthjell K, Daae C, Furuseth K, Hanssen KF: **[NSAMs guidelines for diabetes in general practice 2005. Short version].** Norsk selskap for allmennmedisin, Den norske Lægeforening, Norges Diabetesforbund; 2005.
25. Claudi T, Cooper J, Skogoy K, Hausken MF, Melbye H: **[Diabetic care in Norwegian general practice. A report of current status from Salten and some regions in Rogaland].** *Tidsskr Nor Laegeforen* 1997, **117(25):**3661-3664.
26. Claudi T, Cooper JG, Midthjell K, Daae C, Furuseth K, Hanssen KF: **[NSAMs guidelines for diabetes in general practice. Short version].** Norsk selskap for allmennmedisin, Den norske Lægeforening, Norges Diabetesforbund; 2000.
27. Tapp RJ, Zimmet PZ, Harper CA, de Courten MP, Balkau B, McCarty DJ, Taylor HR, Welborn TA, Shaw JE: **Diabetes care in an Australian population: frequency of screening examinations for eye and foot complications of diabetes.** *Diabetes Care* 2004, **27(3):**688-693.
28. Saaddine JB, Cadwell B, Gregg EW, Engelgau MM, Vinicor F, Imperatore G, Narayan KM: **Improvements in diabetes processes of care and intermediate outcomes: United States, 1988-2002.** *Ann Intern Med* 2006, **144(7):**465-474.
29. Muller A, Lamoureux E, Bullen C, Keeffe JE: **Factors associated with regular eye examinations in people with diabetes: results from the Victorian Population Health Survey.** *Optom Vis Sci* 2006, **83(2):**96-101.
30. Wilson A, Baker R, Thompson J, Grimshaw G: **Coverage in screening for diabetic retinopathy according to screening provision: results from a national survey in England and Wales.** *Diabet Med* 2004, **21(3):**271-278.
31. Muller A, Keeffe JE, Taylor HR: **Changes in eye care utilization following an eye health promotion campaign.** *Clin Experiment Ophthalmol* 2007, **35(4):**305-309.

32. Fowles JB, Rosheim K, Fowler EJ, Craft C, Arrichiello L: **The validity of self-reported diabetes quality of care measures.** *Int J Qual Health Care* 1999, **11(5):**407-412.
33. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Optometric practice in Norway: a cross-sectional nationwide study.** *Acta Ophthalmol Scand* 2007, **85(6):**671-676.
34. Knudsen LL, Lervang HH, Lundbye-Christensen S, Gorst-Rasmussen A: **The North Jutland County Diabetic Retinopathy Study: population characteristics.** *Br J Ophthalmol* 2006, **90(11):**1404-1409.
35. Hove MN, Kristensen JK, Lauritzen T, Bek T: **The prevalence of retinopathy in an unselected population of type 2 diabetes patients from Arhus County, Denmark.** *Acta Ophthalmol Scand* 2004, **82(4):**443-448.
36. Marshall SM, Flyvbjerg A: **Prevention and early detection of vascular complications of diabetes.** *BMJ* 2006, **333(7566):**475-480.

Pre-publication history

The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/1472-6963/8/159/prepub

IV

Sensitivity and specificity of Norwegian optometrists' evaluation of diabetic retinopathy in single-field retinal images – a cross-sectional experimental study

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Abstract

Background

In the working age group, diabetic retinopathy is a leading cause of visual impairment. Regular eye examinations and early treatment of retinopathy can prevent visual loss, so screening for diabetic retinopathy is cost-effective. Dilated retinal digital photography with the additional use of ophthalmoscopy is the most effective and robust method of diabetic retinopathy screening. The aim of this study was to estimate the sensitivity and specificity of diabetic retinopathy screening when performed by Norwegian optometrists.

Methods

This study employed a cross-sectional experimental design. Seventy-four optometrists working in private optometric practice were asked to screen 14 single-field retinal images for possible diabetic retinopathy. The screening was undertaken using a web-based visual identification and management of ophthalmological conditions (VIMOC) examination. The images used in the VIMOC examination were selected from a population survey and had been previously examined by two independent ophthalmologists. In order to establish a “gold standard”, images were only chosen for use in the VIMOC examination if they had elicited diagnostic agreement between the two independent ophthalmologists. To reduce the possibility of falsely high specificity occurring by chance, half the presented images were of retinas that were not affected by diabetic retinopathy. Sensitivity and specificity for diabetic retinopathy was calculated with 95% confidence intervals (CIs).

Results

The mean (95% CI) sensitivity for identifying eyes with any diabetic retinopathy was 67% (62% to 72%). The mean (95% CI) specificity for identifying eyes without diabetic retinopathy was 84% (80% to 89%). The mean (95% CI) sensitivity for identifying eyes with mild non-proliferative diabetic retinopathy or moderate non-proliferative diabetes was 54% (47% to 61%) and 100%, respectively. Only four optometrists (5%) met the required standard of at least 80% sensitivity and 95% specificity that has been previously set for diabetic retinopathy screening programmes.

Conclusions

The evaluation of retinal images for diabetic retinopathy by Norwegian optometrists does not meet the required screening standard of at least 80% sensitivity and 95% specificity. The introduction of measures to improve this situation could have implications for both formal optometric training and continuing optometric professional education.

Keywords

Diabetic retinopathy, optometrist, sensitivity, specificity, retinal images, case finding, screening

Background

Approximately 90,000 to 120,000 Norwegians have known diabetes [1], among whom reported prevalence of diabetic retinopathy (DR) ranges from 11% to 28% [2-5]. In the working age group, DR is a leading cause of visual impairment [6]. Among people with diabetes, 1% to 13% develop sight-threatening diabetic retinopathy (STDR) and 0.4% to 1.3% are visually impaired because of DR [7-13]. Regular eye examinations and early treatment of retinopathy can prevent visual loss [9, 14-16], so screening for DR is cost-effective [17]. Dilated retinal digital photography with the additional use of ophthalmoscopy is the most effective and robust method of DR screening [18, 19]. In Norway, the national guidelines for diabetes [20] and The Norwegian College of General Practitioners [21] recommend either regular eye examinations by an ophthalmologist or the use of retinal photography., The Norwegian Association of Optometry has issued clinical guidelines for optometric practice [22] which include guidelines for the examination and management of patients with diabetes.

People with diabetes are commonly examined in optometric practice due to having refractive errors. Norwegian optometric practice may represent a low threshold setting for case-finding of DR [23]. Studies in other countries have shown that optometrists are able to detect and grade DR [24] and specially trained optometrists perform well when screening for STDR (sensitivity 73%-97% and specificity 83%-99%) [25-29]. Since 1988, the profession in Norway has developed from being populated by opticians to being an approved healthcare profession, populated by optometrists. Consequently, Norwegian optometrists are a heterogeneous group with regard to formal education [30]. In 2004, optometrists were granted the right to prescribe

diagnostic ocular drugs and since 2009 they have been able to refer patients directly to an ophthalmologist, without the patient first seeing a gate-keeping general practitioner (GP). These two responsibilities warrant a high standard of performance on the part of the optometrist.

Sensitivity and specificity define the ability of a clinical test to correctly identify people with and without a specific disease. For low prevalence diseases, a high specificity is required to avoid large numbers of false positive results. The British Diabetic Association (now Diabetes UK) has set a required screening standard for DR of at least 80% sensitivity and 95% specificity [31]. The aims of the current study were to assess the sensitivity and specificity of the optometrists' diagnosis of DR and to assess sensitivity and specificity with respect to the optometrists' formal education. Furthermore, we wanted to investigate how the optometrists intended to follow up their cases.

Methods

A cross-sectional experimental design was employed. The study population, from which study participants were drawn, comprised authorized optometrists in Norway (n≈1850). Members of the Norwegian Association of Optometry (NOF) (n=1028) were invited to participate by e-mail. Only those optometrists who were currently working in private practice, who had worked in private practice for the previous 6 months and who intended to continue working in private practice for the following 6 months were eligible for inclusion in the study.

Those optometrists who responded positively to our e-mail and were subsequently accepted for inclusion in the study were sent an interactive web-based visual identification and management of ophthalmological conditions (VIMOC) examination that used Question Writer 4 software. A VIMOC examination tests clinical competency using cases and/or images with accompanying multiple choice questions [32]. The examination consisted of 14 retinal images which the optometrists were to assess with respect to the presence or absence of DR, without grading severity. Additionally, they were to decide on patient management, based solely on retinal findings and making the assumption that the patient had never been examined by an ophthalmologist. No grading scales or patient management guidelines were provided and the optometrists were not given any patient information, such as visual acuity data. It was possible to move back and forth in the VIMOC exam to review the images and revise prior assessments before submitting a final response. In addition, a questionnaire was included to gather information regarding the participants' work experience, education, preferred method of retinal examination, methods used for retinal examination in patients with diabetes, and methods available to them for retinal examination and imaging. Optometrists used their own computers with screen resolution and colour set to maximum. Screen resolution ranged from 1024x600 to 2560x1440 pixels.

The study followed the tenets of the Declaration of Helsinki for research involving humans and was approved by the Regional Committee for Medical Research Ethics. The VIMOC retinal images were obtained from a previous Norwegian population survey [2]. Blinded to patient information, all images had been independently assessed by two ophthalmologists who graded the presence of retinopathy according

to the Diabetic Retinopathy Disease Severity Scale [33]. The ophthalmologists viewed the images on a 21" monitor with screen resolution of 1600x1200 pixels. From a total of 239 images, only those that had been graded with full agreement between the two ophthalmologists (n=217) were considered for inclusion in our study. Seven images of retinas affected by non-proliferative diabetic retinopathy (NPDR) and seven images of retinas unaffected by DR were randomly selected. The DR images included five examples of mild NPDR (Figure 1) and two examples of moderate, potentially sight threatening NPDR (Figure 2). To reduce the possibility of falsely high specificity occurring by chance, half of the presented images were of retinas that were not affected by DR. The diagnoses of the two ophthalmologists for each image were used as a "gold standard" against which the performance of the study participants was assessed.

The required sample size of participants was calculated based on the following: 50% prevalence of DR in the image sample, a standard deviation of true sensitivity and specificity for individual optometrists' image evaluation of 0.2, and 50% sensitivity and specificity for detecting DR by individual optometrists to allow maximum variance. It was calculated that a CI < 0.05 for sensitivity and specificity for any diabetic retinopathy (ADR) could be achieved with 100 study participants, meaning that sensitivity and specificity was calculated with 95% confidence interval for any retinopathy. Study participants were not asked to grade DR; the sensitivity of mild and moderate NPDR was assessed in terms of detection of retinopathy in images with mild and moderate NPDR, respectively. The screening standard established by the British Diabetic Association (Diabetes UK) of at least 80% sensitivity and 95% specificity for ADR [31] was used as the screening standard in our study. Potential

associations between test performance and formal education were investigated and analysed using Pearson Chi-square and student-t tests; a p-value ≤ 0.05 was regarded as significant.

Data were collected in the period between 28th February and 14th March 2011; reminders requesting participants to complete the test were sent once.

Results

In all, 112 (11%) members of NOF responded positively to the e-mail and volunteered to participate in this study. Of these 112, 101 (90%) met the inclusion criteria, and 74 (73%) completed the study. Participants were generally educated to a higher level than the average for Norwegian optometrists (Table 1).

The optometrists' preferred methods of retinal examination were reported to include undilated indirect ophthalmoscopy (47% of participants) and undilated retinal fundus photography (34% of participants). Multiple examination methods were reported for patients with diabetes (Table 2). Twenty-three percent of participants reported that they undertook dilated retinal examinations in patients with diabetes.

The optometrists' assessments of each of the 14 VIMOC images are presented in Table 3. Optometrists with higher optometric education (a Master of Science in clinical optometry [MSc]) demonstrated significantly higher sensitivity than those who had a basic optometric education (Table 4). The specificity was not influenced by the optometrist education level.

No association was found either between sensitivity or specificity and the number of years of experience in optometric practice, or between sensitivity or specificity and the participants' preferred method of retinal examination. The screening standard for sensitivity of at least 80% and specificity of at least 95%, for ADR, was met by 24 (32%) and 31 (42%) optometrists, respectively, overall. The standards for sensitivity and specificity were met by 50% and 45%, respectively, of optometrists who held an MSc and by 25% and 39%, respectively, who had a basic optometric education. Only four optometrists (5%) met the required standard for both sensitivity and specificity.

Patient management decisions were dependent on retinal findings (Table 5). Report/referral to a GP and/or an ophthalmologist was regarded as appropriate for 99% and 96% of true- and false-positive findings, respectively. The rate of referral to an ophthalmologist was higher for moderate than for mild NPDR (92% vs. 62%). No further management was considered appropriate in 68% and 66% of cases of true- and false-negative findings, respectively.

Discussion

Only 5% of the responding optometrists satisfied the screening standard established by the British Diabetic Association of at least 80% sensitivity and 95% specificity [31]. Overall, sensitivity for detecting ADR was low and specificity was moderate. Sensitivity for detecting potential STDR was, however, high. This suggests that the optometrists' assessment of retinal images is an unreliable method of screening for DR. The sensitivity and specificity of detection of DR in the current study and previous studies is presented in Table 6. It is not possible to make a direct comparison between the current study and previous studies that involved community optometrists

[28, 34], as those studies did not report sensitivity and specificity levels for individual optometrists. However, based on the reported mean levels of sensitivity and specificity, it is unlikely that individual optometrists in those studies would have met the British Diabetic Association screening criteria. The sensitivity for detecting ADR in our study (67%) was lower than that reported by Gibbins et al. (86-88%) [28]. However, the sensitivity for detecting *STDR* was higher in our study than in either the Gibbins et al. or Buxton et al studies (100% vs. 47-97%) [28, 34] and the specificity was similar (84% vs. 83-95%). The greater sensitivity for detecting STDR in the current study could have been a result of the higher prevalence of STDR in our VIMOC sample compared with these earlier studies, which may have inflated sensitivity by chance. The prevalence of ADR in our study was comparable with the prevalence of ADR in the study by Gibbins et al. [28]. In that study, optometrists had received special training in the identification and grading of DR, which could explain the relatively high sensitivity levels observed.

We have found that sensitivity, but not specificity, was influenced by the level of formal education the participants had received. Optometrists with an MSc had a significantly higher sensitivity than optometrist with a basic optometric education. This suggests that our results give a better estimate of sensitivity and specificity in general optometric practice, as our study included optometrists who had not had any special training in screening for DR.

The sensitivity observed in this study is in line with that observed in a previous study we undertook to investigate Norwegian general optometric practice [23], where sensitivity ranged from 61% to 65%, based on an assumption of 14% prevalence of

DR among patients with diabetes [3]. Specificity in the current study was, however, lower than in our previous study (84% vs. 98-100%), which could be explained by the difference in prevalence between the two studies. In the current study, 98% of findings of DR (both true- and false-positives) were considered to warrant a report/referral to a physician. This is higher than the rate of 57% reported in a national practice registration in Norway [23]. The experimental design in our study, where optometrists were blinded to patient information but assumed that the patient had never been examined by an ophthalmologist, may have led to an increased tendency to recommend referral to a physician.

Assuming the prevalence of DR is 14% [3], the negative and positive predictive values of the optometrists' evaluation of DR in our study would be 94% and 41%, respectively. Based on this and on the fact that Norwegian optometrists undertake approximately 1 million eye examinations per year (of which approximately 4% are in patients with diabetes [30]), our findings suggest that each year approximately 5500 patients without DR are referred based on a false positive result, while in approximately 1300 patients with DR, no further action is taken. However, if the British Diabetic Association screening criteria were met in Norwegian optometric practice, these figures would be 1700 and 800, respectively. Our results suggest that an excessive workload is being placed on healthcare services by inaccurate referral practices. However, the national guidelines recommend eye examination by ophthalmologists [20, 21], thus the report/referral of a patient who has not previously been seen by an ophthalmologist should not be discouraged. Of greater concern is the false security given to those patients with DR who are not referred to an ophthalmologist.

The strengths of this study are the use of standardised images in the VIMOC exam and the use of a diagnostic "gold standard" based on 100% agreement between two independent ophthalmologists. The experimental design allowed the calculation of sensitivity and specificity with acceptable precision in a relatively large nationwide sample of optometrists, something that was not achieved in previous studies [25-28, 34]. In terms of gender, number of years in practice and geographical location, our sample of optometrists is representative of members of the NOF and of optometrists who participated in a previous study of Norwegian optometric practice [23, 30]. The potential for knowledge bias and overestimation of sensitivity and specificity for general optometric practice was reduced in the current study because the optometrists were not provided with grading scales, nor were they given specific training prior to the study.

One potential limitation of the study was the possibility of selection bias, as optometrists with a specific interest in diabetes may have been more likely to accept the invitation to participate and hence may have been overrepresented in the study. This could have inflated the sensitivity levels observed, compared with general optometric practice. On the other hand, participating optometrists did not have specific training in screening for DR, nor were they provided with a DR grading scale or a computer screen that would facilitate classification of DR. Variable viewing conditions may have influenced the detection rate of DR. Small screen size, low screen resolution and inadequate colour setting may have led to lower sensitivity for detecting mild DR. On the other hand, the optometrists' use of their own facilities

simulated real practice, something that the use of perfect viewing conditions could not have done.

Conclusions

Our study is likely to have given a better representation of general optometric practice than previous studies [25-28, 34]. However, our findings indicate that at present case-finding of DR in Norwegian optometric practice is unreliable. Formal optometric training in screening for DR and continuing education may improve diagnostic sensitivity. Further research will be needed to evaluate the effectiveness of measures undertaken to improve optometrists' diagnostic accuracy for case-finding of DR.

List of abbreviations

ADR, any diabetic retinopathy; CI, confidence interval; DR, diabetic retinopathy; GP, general practitioner; MSc, Master of Science in clinical optometry; NOF, Norwegian Association of Optometry; NPDR, non-proliferative diabetic retinopathy; STDR, sight-threatening diabetic retinopathy; VIMOC, visual identification and management of ophthalmological conditions

Competing interests

The authors declare that they have no financial or non-financial competing interests.

Authors' contributions

VS conceived of the study and participated in its design, acquired and statistically analysed the data and drafted the manuscript. PG and JS participated in the design of the study and critically revised the manuscript. All authors read and approved the final manuscript.

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Acknowledgements

We thank the optometrists participating in the study and Fredrik A. Dahl, HØKH, Research Centre for statistical advice.

References

1. Stene LC, Midthjell K, Jenum AK, Skeie S, Birkeland KI, Lund E, Joner G, Tell GS, Schirmer H: **Hvor mange har diabetes mellitus i Norge? [Prevalence of diabetes mellitus in Norway]**. *Tidsskr Nor Laegeforen* 2004, **124**(11):1511-1514.
2. Sundling V, Platou CG, Jansson RW, Bertelsen G, Wøllo E, Gulbrandsen P: **Retinopathy and visual impairment in diabetes, impaired glucose tolerance and normal glucose tolerance: the Nord-Trondelag Health Study (the HUNT study)**. *Acta Ophthalmol* 2010.
3. Hapnes R, Bergrem H: **Diabetic eye complications in a medium sized municipality in southwest Norway**. *Acta Ophthalmol Scand* 1996, **74**(5):497-500.
4. Kilstad HN, Sjolie AK, Goransson L, Hapnes R, Henschien HJ, Alsbirk KE, Fossen K, Bertelsen G, Holstad G, Bergrem H: **Prevalence of diabetic retinopathy in Norway: report from a screening study**. *Acta Ophthalmol* 2011.
5. Bertelsen G, Peto T, Lindekleiv H, Schirmer H, Solbu MD, Toft I, Sjolie AK, Njolstad I: **Tromso eye study: prevalence and risk factors of diabetic retinopathy**. *Acta Ophthalmol* 2012.
6. Porta M, Bandello F: **Diabetic retinopathy A clinical update**. *Diabetologia* 2002, **45**(12):1617-1634.
7. Olafsdottir E, Andersson DK, Stefansson E: **Visual acuity in a population with regular screening for type 2 diabetes mellitus and eye disease**. *Acta Ophthalmol Scand* 2007, **85**(1):40-45.
8. Scanlon PH, Foy C, Chen FK: **Visual acuity measurement and ocular co-morbidity in diabetic retinopathy screening**. *Br J Ophthalmol* 2008, **92**(6):775-778.
9. Zoega GM, Gunnarsdottir T, Bjornsdottir S, Hreietharsson AB, Viggosson G, Stefansson E: **Screening compliance and visual outcome in diabetes**. *Acta Ophthalmol Scand* 2005, **83**(6):687-690.
10. Jeppesen P, Bek T: **The occurrence and causes of registered blindness in diabetes patients in Arhus County, Denmark**. *Acta Ophthalmol Scand* 2004, **82**(5):526-530.
11. Prasad S, Kamath GG, Jones K, Clearkin LG, Phillips RP: **Prevalence of blindness and visual impairment in a population of people with diabetes**. *Eye* 2001, **15**(Pt 5):640-643.
12. Broadbent DM, Scott JA, Vora JP, Harding SP: **Prevalence of diabetic eye disease in an inner city population: the Liverpool Diabetic Eye Study**. *Eye* 1999, **13**:160-165.
13. Hove MN, Kristensen JK, Lauritzen T, Bek T: **The prevalence of retinopathy in an unselected population of type 2 diabetes patients from Arhus County, Denmark**. *Acta Ophthalmol Scand* 2004, **82**(4):443-448.
14. Backlund LB, Algvere PV, Rosenqvist U: **New blindness in diabetes reduced by more than one-third in Stockholm County**. *Diabet Med* 1997, **14**(9):732-740.
15. Kristinsson JK, Hauksdottir H, Stefansson E, Jonasson F, Gislason I: **Active prevention in diabetic eye disease. A 4-year follow-up**. *Acta Ophthalmol Scand* 1997, **75**(3):249-254.

16. Stefansson E, Bek T, Porta M, Larsen N, Kristinsson JK, Agardh E: **Screening and prevention of diabetic blindness**. *Acta Ophthalmol Scand* 2000, **78**(4):374-385.
17. Javitt JC, Aiello LP: **Cost-effectiveness of detecting and treating diabetic retinopathy**. *Ann Intern Med* 1996, **124**(1 Pt 2):164-169.
18. Hutchinson A, McIntosh A, Peters J, O'Keeffe C, Khunti K, Baker R, Booth A: **Effectiveness of screening and monitoring tests for diabetic retinopathy--a systematic review**. *Diabet Med* 2000, **17**(7):495-506.
19. Gillibrand W, Broadbent D, Harding S, Vora J: **The English national risk-reduction programme for preservation of sight in diabetes**. *Mol Cell Biochem* 2004, **261**(1-2):183-185.
20. Helsedirektoratet: **Nasjonale faglige retningslinjer (IS-1674). Diabetes - Forebygging, diagnostikk og behandling [National professional guidelines. Diabetes - Prevention, diagnostics and treatment]**. Oslo: Helsedirektoratet; 2009.
21. Claudi T, Cooper JG, Midthjell K, Daae C, Furuseth K, Hanssen KF: **NSAMs handlingsprogram for diabetes i allmennpraksis 2005 (NSAMs guidelines for diabetes in general practice 2005)**. 2005.
22. Norges Optikerforbund: **Retningslinjer i klinisk optometri**. Oslo: Norges Optikerforbund; 2005.
23. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Suspected retinopathies in Norwegian optometric practice with emphasis on patients with diabetes: a cross-sectional study**. *BMC Health Services Research* 2008, **8**:38.
24. Schmid KL, Swann PG, Pedersen C, Schmid LM: **The detection of diabetic retinopathy by Australian optometrists**. *Clinical and Experimental Optometry* 2002, **85**(4):221-228.
25. Olson JA, Strachan FM, Hipwell JH, Goatman KA, McHardy KC, Forrester JV, Sharp PF: **A comparative evaluation of digital imaging, retinal photography and optometrist examination in screening for diabetic retinopathy**. *Diabet Med* 2003, **20**(7):528-534.
26. Hulme SA, Tin UA, Hardy KJ, Joyce PW: **Evaluation of a district-wide screening programme for diabetic retinopathy utilizing trained optometrists using slit-lamp and Volk lenses**. *Diabet Med* 2002, **19**(9):741-745.
27. Prasad S, Kamath GG, Jones K, Clearkin LG, Phillips RP: **Effectiveness of optometrist screening for diabetic retinopathy using slit-lamp biomicroscopy**. *Eye* 2001, **15**(Pt 5):595-601.
28. Gibbins RL, Owens DR, Allen JC, Eastman L: **Practical application of the European Field Guide in screening for diabetic retinopathy by using ophthalmoscopy and 35 mm retinal slides**. *Diabetologia* 1998, **41**(1):59-64.
29. Harvey JN, Craney L, Nagendran S, Ng CS: **Towards comprehensive population-based screening for diabetic retinopathy: operation of the North Wales diabetic retinopathy screening programme using a central patient register and various screening methods**. *J Med Screen* 2006, **13**(2):87-92.
30. Sundling V, Gulbrandsen P, Bragadottir R, Bakketeig LS, Jervell J, Straand J: **Optometric practice in Norway: a cross-sectional nationwide study**. *Acta Ophthalmol Scand* 2007, **85**(6):671-676.

31. British Diabetic Association: **Retinal photographic screening for diabetic eye disease. A British Diabetic Association Report**. London: British Diabetic Association; 1997.
32. Aakre BM, Svarverud E: **Utdanning for klinisk kompetanse (Education towards clinical competence)**. *Optikeren* 2011(5):52-53.
33. Wilkinson CP, Ferris FL, 3rd, Klein RE, Lee PP, Agardh CD, Davis M, Dills D, Kampik A, Pararajasegaram R, Verdaguer JT: **Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales**. *Ophthalmology* 2003, **110**(9):1677-1682.
34. Buxton MJ, Sculpher MJ, Ferguson BA, Humphreys JE, Altman JF, Spiegelhalter DJ, Kirby AJ, Jacob JS, Bacon H, Dudbridge SB *et al*: **Screening for treatable diabetic retinopathy: a comparison of different methods**. *Diabet Med* 1991, **8**(4):371-377.

Figures

Tables

Table 1 Characteristics of Norwegian optometrists

Information as registered by the Norwegian Association of Optometry (NOF) and reported by the participating optometrists.

Table 2 Characteristics of participating optometrists by formal education

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Table 3 Optometrists' VIMOC evaluations of retinal images and corresponding ophthalmologist grading and patient glucose status

Table 4 Optometrists' sensitivity and specificity for identifying diabetic retinopathy, presented by formal education level

Table 5 Individual image evaluation and suggested follow-up

The 74 optometrists' evaluation of the 14 retinal images (1036 evaluations) and suggested interactions as part of follow-up, presented by true- and false-positive and -negative ratings, respectively

Table 6 Optometrists' sensitivity and specificity for identifying diabetic retinopathy as reported in the current study and previous studies

Table 1 Characteristics of Norwegian optometrists

Information as registered by the Norwegian Association of Optometry (NOF) and reported by the participating optometrists

	Members of NOF[a]		
	All members (*n*=1028)	Non-participants (*n*=954)	Participants (*n*=74)
Gender *n*, (%)			
Male	472 (46)	441 (46)	31 (42)
Female	556 (54)	513 (54)	43 (58)
Practice by national health region *n*, (%)			
East	338 (33)	317 (33)	21 (28)
South	293 (29)	276 (29)	20 (27)
West	176 (17)	165 (17)	11 (15)
Middle	135 (13)	119 (12)	16 (22)
North	83 (8)	77 (8)	6 (8)
Higher education *n*, (%)			
Master of science in clinical optometry [b] *	200 (20)	178 (19)	22 (30)
Private optometric practice *n*, (%) ‡	870 (88)	796 (87)	74 (100)

[a] Members of the NOA February 2011
[b] Missing data for 37 optometrists
Pearson Chi-square P*< 0.05 between participants and non-participants

Table 2 Characteristics of participating optometrists by formal education

Gender, work experience, available and preferred methods for retinal examination by optometrists formal education of Master of Science or not.

		Master of Science in Clinical Optometry[a]	
	All (*n*=74)	No (*n*=51)	Yes (*n*=22)
Gender, *n* (%)			
Female	43 (58)	30 (59)	13 (59)
Male	31 (42)	21 (41)	9 (41)
Number of years as practicing optometrist, mean (sd) **	12 (±9)	10 (±8)	16 (±8)
Preferred method of retinal examination, *n* (%)			
Undilated indirect ophthalmoscopy	35 (47)	22 (43)	13 (59)
Retinal fundus photography	25 (34)	16 (31)	8 (36)
Undilated direct ophthalmoscopy	9 (12)	9 (17)	0 (0)
Other	5 (7)	4 (8)	1 (1)
Retinal examinations methods used in patients with diabetes, *n* (%)			
Undilated retinal photography	46 (62)	30 (59)	15 (68)
Undilated indirect ophthalmoscopy*	39 (53)	23 (45)	16 (73)
Dilated indirect ophthalmoscopy	15 (20)	9 (18)	6 (27)
Dilated retinal photography	11 (15)	8 (16)	3 (14)
Undilated direct ophthalmoscopy*	11 (15)	11 (22)	0 (0)
Available instruments for retinal examination and imaging, *n* (%)			
Direct ophthalmoscope and/or indirect slit-lamp ophthalmoscopy	71 (96)	48 (94)	22 (100)
Retinal fundus camera	65 (88)	44 (86)	20 (91)
Scanning-laser ophthalmoscope (Optomap)	19 (26)	10 (20)	9 (41)

[a]Missing data for 1 participant

Student t-test P*<0.05 and P**<0.01 between optometrists with and without MSc in clinical optometry

Table 3 Optometrists' VIMOC evaluations of retinal images and corresponding ophthalmologist grading and patient glucose status

Image[a]	Patient status	Image evaluation			Optometrist consideration on further management					
		Ophthalmologists Grading of DR	Optometrists True findings of DR		No/Routine follow-up		Report / referral to general practitioner		Report / referral to ophthalmologist	
			n	% (95%CI)	*n*	% (95%CI)	*n*	% (95%CI)	*n*	% (95%CI)
8	IGT	No DR	46	64 (52 to 75)	17	37 (23 to 51)	21	46 (31 to 60)	8	17 (6 to 28)
5	KDM	No DR	53	72 (61 to 82)	30	37 (43 to 70)	10	19 (8 to 29)	13	25 (13 to 36)
14	SDDM	No DR	61	82 (74 to 91)	31	51 (38 to 63)	18	30 (18 to 41)	12	20 (10 to 30)
13	SDDM	No DR	64	86 (79 to 94)	33	52 (39 to 64)	10	16 (7 to 25)	21	33 (21 to 44)
12	SDDM	No DR	68	92 (86 to 98)	58	85 (77 to 94)	4	6 (0 to 11)	6	9 (2 to 16)
11	KDM	No DR	71	96 (91 to 100)	61	86 (78 to 94)	2	3 (0 to 7)	8	11 (4 to 19)
2	NGT	No DR	73	99 (96 to 100)	66	90 (84 to 97)	4	5 (0 to 11)	3	4 (0 to 9)
1	NGT	Mild NPDR	23	31 (20 to 42)	1	4 (0 to 13)	8	35 (15 to 54)	14	61 (41 to 81)
6	IGT	Mild NPDR	39	53 (41 to 64)	1	3 (0 to 8)	10	26 (12 to 39)	28	72 (58 to 86)
3	NGT	Mild NPDR	40	54 (42 to 66)	0	0 (0 to 0)	19	48 (32 to 63)	21	53 (37 to 68)
7	DM	Mild NPDR	41	55 (44 to 67)	1	2 (0 to 7)	15	37 (22 to 51)	25	61 (46 to 76)
4	DM	Mild NPDR	57	77 (67 to 87)	2	4 (0 to 8)	20	35 (23 to 47)	35	61 (49 to 74)
9[b]	DM	Moderate NPDR	71	100 (100 to 100)	0	0 (0 to 0)	4	6 (0 to 11)	67	94 (89 to100)
10[c]	DM	Moderate NPDR	73	100 (100 to 100)	0	0 (0 to 0)	8	11 (4 to 18)	65	89 (82 to 96)

CI, confidence interval; DR, diabetic retinopathy; IGT, impaired glucose tolerance; KDM, known diabetes;, NGT, normal glucose tolerance; NPDR, non-proliferative diabetic retinopathy; SDDM, screen-detected diabetes; VIMOC, Visual Identification and Management of Ophthalmological Conditions.

[a] The number refers to the number in image presentation sequence of the VIMOC examination

Missing grading data from [b]3 and [c]1 optometrists

Table 4 Optometrists' sensitivity and specificity for identifying diabetic retinopathy, presented by formal education level

	Sensitivity			Specificity
	Any DR (*n*=7)	Mild DR (*n*=5)	Moderate DR (*n*=2)	No DR (*n*=7)
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
All optometrists (*n*=74)	67 (62 to 72)	54 (47 to 61)	100	84 (80 to 89)
Formal education[a],**				
BSc or lower (*n*=51)	63 (56 to 69)	48 (39 to 57)	100	84 (78 to 89)
MSc (*n*= 22)	77 (71 to 84)	68 (59 to 77)	100	85 (77 to 93)

BSc, Bachelor of science; CI, confidence interval; DR, diabetic retinopathy; MSc, master of science.
[a] Missing data for 1 optometrist.
Student t-test P**<0.01 statistically significant difference in sensitivity between optometrists with MSc and optometrists with BSc or even lower formal education

Table 5 Individual image evaluation and suggested follow-up

The 74 optometrists' evaluation of the 14 retinal images (1036 evaluations) and suggested interactions as part of follow-up, by true and false positive and negative ratings, respectively

	Images with diabetic retinopathy (*n*=518)				Images without diabetic retinopathy (*n*=518)			
	True positive Sensitivity		False negative		True negative Specificity		False positive	
	n	%	*n*	%	*n*	%	*n*	%
Screening standard set to meet [a]	414	80	104	20	492	95	26	5
	n	% (95%CI)	*n*	% (95%CI)	*n*	% (95%CI)	*n*	% (95%CI)
Optometrists' image evaluation	348	67 (62 to 72)	170	32 (28 to 38)	437	84 (80 to 89)	81	16 (11 to 20)
Further management[b]								
None / Routine follow up	5	1 (0 to 3)	113	66 (59 to 74)	296	68 (64 to 72)	3	4 (0 to 8)
Report / referral to general practitioner	84	24 (20 to 29)	41	24 (18 to 21)	69	16 (12 to 19)	39	48 (37 to 59)
Report / referral to ophthalmologist	255	74 (70 to 79)	16	9 (5 to 14)	71	16 (13 to 20)	39	48 (37 to 59)

[a] British Diabetic Association. Retinal photographic screening for diabetic eye disease. A British Diabetic Association Report. London: British Diabetic Association; 1997.
[b] Data missing for 5 image evaluations

Table 6 Optometrists' sensitivity and specificity for identifying diabetic retinopathy as reported in the current study and previous studies

Study	Retinal examination method	Sensitivity (95%CI)		Specificity (95%CI)	
		ADR	STDR	ADR	STDR
Our study (2011)					
Community optometrists	Image evaluation of digital images	67 (62 to 72)		84 (80 to 89)	
Harvey et al (2006)					
Optometrists in a screening program	Not available		80 (71 to 89)		99 (98 to 100)
Olson et al (2003)					
Specially trained optometrists	Dilated slit-lamp examination		73 (52 to 88)		90 (87 to 93)
Schmid et al (2002)					
Community optometrists	Ophthalmoscopy (free choice)	92 (84 to 100)		94 (90 to 98)	
	Image evaluation of retinal slides	94 (90 to 98)		97 (92 to 100)	
Hulme et al (2001)					
Specially trained optometrists	Dilated slit-lamp examination	72	87	77	91
Prasad et al (2001)					
Specially trained optometrists	Dilated slit-lamp examination	66 (65 to 67)	76 (70 to 81)	97 (97 to 98)	95 (95 to 96)
Gibbins et al (1998)					
Community optometrists	Image evaluation of 35 mm slides	88 (83 to 93)	91 (79 to 98)	68 (58 to 68)	83 (79 to 87)
Specially trained optometrist	Image evaluation of 35 mm slides	86 (81 to 91)	97 (90 to 100)	89 (85 to 93)	87 (84 to 91)
Buxton et al (1991)					
Community optometrists	Image evaluation of Polaroid images	48 (26 to 69)		94 (92 to 97)	

ADR, any diabetic retinopathy, STDR, sight-threatening diabetic retinopathy

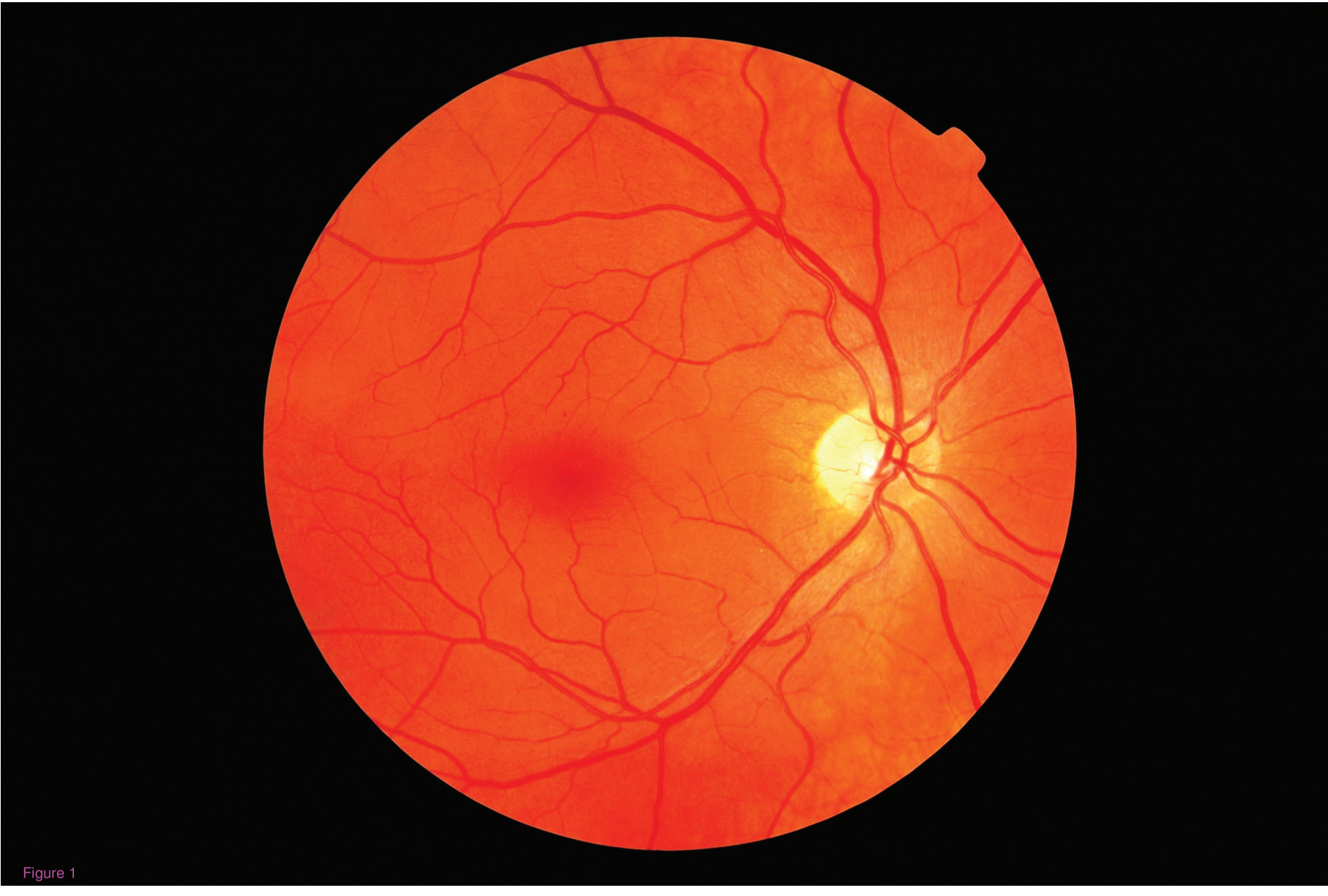


Figure 1

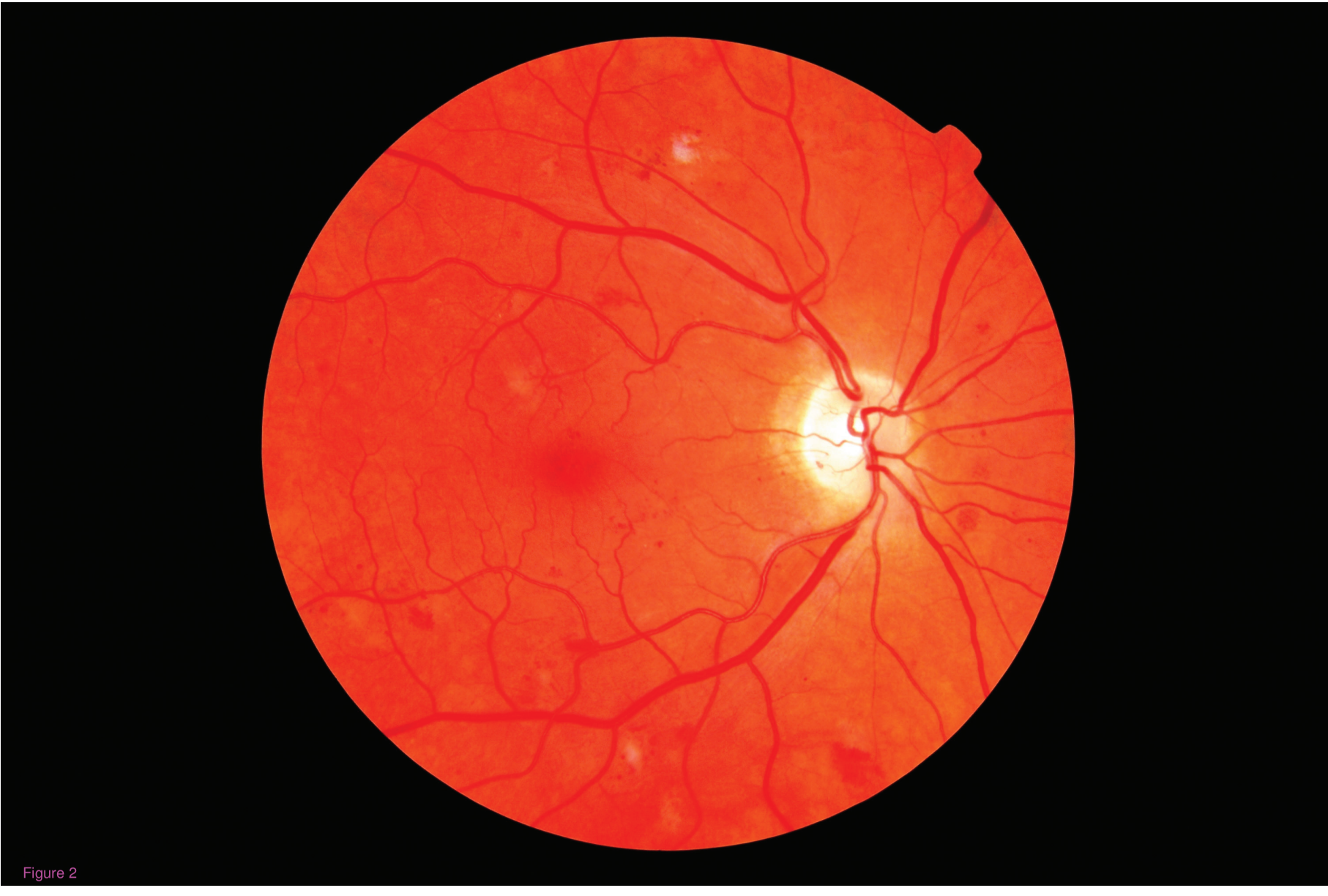
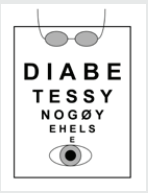


Figure 2

Appendix 1

IDNR:



HVA GJØR DU?

DIABETES I OPTOMETRISK PRAKSIS - 1

Dette spørreskjemaet vil bli benyttet til å kartlegge optometrisk praksis i Norge ved synsundersøkelse av *pasienter med diabetes*.

Kartleggingen er en del av doktorgradsprosjektet:
DIABETES, SYN OG ØYEHELSE

Har du spørsmål angående undersøkelsen kontakt:
Vibeke Sundling, Institutt for optometri og synsvitenskap, HiBu, Pb 251, 3601 Kongsberg
Telefon 32 86 97 59, mobil: 924 24 360, e-post: vibeke.sundling@hibu.no

Bruk penn ved utfylling av skjemaet, og returner det i vedlagte svarkonvolutt.

All informasjon vil bli behandlet konfidensielt. Prosjektet er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Deltagelse i undersøkelsene er frivillig. Du kan på et hvilket som helst tidspunkt før prosjektslutt (31.12.2007) trekke samtykket (svaret på undersøkelsen) tilbake og få opplysningene du har oppgitt makulert uten å oppgi grunn. Datamaterialet vil bli anonymisert innen 31.12.2007. Du vil ikke kunne identifiseres i publikasjoner fra studiet.

Dersom du ikke ønsker å besvare spørreskjemaet, sett kryss her og returner skjemaet!

Jeg ønsker ikke å besvare spørreskjemaet ☐

Årsak (frivillig):

- ☐ Jobber ikke klinisk
- ☐ Jobber ikke som optiker
- ☐ Pensjonist
- ☐ I permisjon / sykemeldt / arbeidsledig
- ☐ Har ikke tid
- ☐ Svarer ikke på spørreundersøkelser
- ☐ Annet

1. **Kjønn** ❑ Mann ❑ Kvinne

2. **Alder** _____ år

3. **Optisk / optometrisk utdanning** (høyeste utdanning)
   - ❑ Yrkesfaglig
   - ❑ 2årig høgskole
   - ❑ 3-årig høgskole
   - ❑ Bachelor grad
   - ❑ Mastergrad

4. **Optisk/optometrisk yrkeserfaring** _____ år

5. **Stillingsstørrelse nå: ____ timer/uke**

6. **Kurs / spesialistkompetanse** (sett gjerne flere kryss)
   - ❑ Diagnostiske medikamenter
   - ❑ Kontaktlinser
   - ❑ ORAS (optometrisk rehabilitering av synshemmede)
   - ❑ Arbeidsplassoptometri
   - ❑ Fremre segment
   - ❑ Adferdsoptometri
   - ❑ Annet _____
     _____

7. **Arbeidssted** (sett flere kryss dersom relevant)
   - ❑ By > 50 000 innbyggere
   - ❑ By < 50 000 innbyggere
   - ❑ Tettsted

8. **Type praksis**
   - ❑ Kjedeuavhengig
   - ❑ Medlemseiet kjede
   - ❑ Sentraleiet kjede
   - ❑ Annet _____
     _____

9. **I hvilken helseregion arbeider du?**

- ❑ Øst (Østfold, Akerhus, Oslo, Hedmark, Oppland)
- ❑ Sør (Vestfold, Buskerud, Telemark, Aust-Agder, Vest-Agder)
- ❑ Vest (Rogaland, Hordaland, Sogn og Fjordane)
- ❑ Midt-Norge (Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag)
- ❑ Nord-Norge (Nordland, Troms, Finnmark)

De neste spørsmålene, spørsmål 10-15, er relatert til synsundersøkelse generelt.

10. **Hvilke av følgende undersøkelser har du vanligvis med i synsundersøkelsen din?**

(sett flere kryss)

- ❑ Anamnese
- ❑ Covertest
- ❑ Motilitet
- ❑ Donders / konfrontasjonstest
- ❑ Refraksjon (subjektiv/objektiv)
- ❑ Spaltelampeundersøkelse (fremre segment)
- ❑ Oftalmoskopi (direkte/indirekte)
- ❑ Tonometri hos alle
- ❑ Tonometri hos alle over ____ år
- ❑ Amsler grid
- ❑ Synsfeltsscreening hos alle
- ❑ Synsfeltsscreening hos alle over ___ år
- ❑ Synsfeltsscreening kun ved mistanke om synsfeltutfall

11. **Hvor mange synsundersøkelser utfører du vanligvis pr. uke?**

Eksl. kontaktlinser: _____ stk Inkl. kontaktlinser: _____ stk

For spørsmål 12 og 13; angi på en skala hvor 0% = aldri og 100%= alltid. Sett kun 1 kryss!

12. **Hvor ofte spør du om pasientens generelle helsetilstand?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

13. **Hvor ofte spør du om pasienten har diabetes?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

14. **Hvor stor andel av de som kommer til synsundersøkelse, anslår du, har kjent diabetes?**

_____%

15. **Dersom pasienten har diabetes foretar du flere / andre undersøkelser enn du normalt gjør?**

❑ Ja ❑ Nei

De neste spørsmålene, spørsmål 16-35 omhandler hva du vanligvis foretar deg dersom den som kommer til synsundersøkelse ***oppgir å ha diabetes****. Alle undersøkelsene er ikke nødvendigvis like viktige.*

Angi på en skala hvor 0% = aldri og 100%= alltid. Sett kun 1 kryss!

Dersom pasienten har diabetes; hvor ofte spør du om:

16. **Hvilken type diabetes pasienten har?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

17. **Hvor lenge pasienten har hatt diabetes?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

18. **Hvor godt blodsukkernivået er regulert?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

19. **Hvor høyt blodtrykket er?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

20. **Hvilken type diabetesbehandling (kost, tabletter, insulin) pasienten får?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

21. **Hvordan pasientens øyehelse følges opp?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

22. **Hva slags øyebehandling pasienten har fått?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

23. **Pasienten opplever/har opplevd at visus varierer?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

24. **Pasienten har opplevd dobbeltsyn?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

25. **Pasienten har opplevd TIA (forbigående synstap)?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

Angi på en skala hvor 0% = aldri og 100%= alltid. Sett kun 1 kryss!

Dersom pasienten har diabetes; hvor ofte foretar du følgende undersøkelser?

26. **Vurderer om refraksjonen er stabil?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

27. **Cover- og motilitetstest?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

28. **Fargesynstest?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

29. **Tonometri (trykkmåling)?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

30. **På hvilken indikasjon blir tonometri (trykkmåling) foretatt?**

_____

_____

31. **Synsfeltundersøkelse (inkl. Donders og/eller Amsler) ?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

32. **På hvilken indikasjon foretar du synsfeltundersøkelse?**

_____

_____

33. **Spaltelampeundersøkelse av fremre segment?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

34. **Fundusundersøkelse?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

35. **Fundusfotografering?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

De neste spørsmålene, spørsmål 36-45 , er relatert til fundusundersøkelse generelt og hvordan du vurderer dine egen evne til å utføre undersøkelsene.

Angi på en skala hvor 0% = aldri og 100%= alltid. Sett kun 1 kryss!

Hvor ofte benytter du følgende teknikker for fundusundersøkelse?

36. **Dilatert fundus undersøkelse?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

37. **Direkte oftalmoskopi?** (vanlig oftalmoskopi)

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

38. **Spaltelampe (binokulær) indirekte oftalmoskopi?** (Volk linse)

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

39. **Monokulær indirekte oftalmoskopi?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

40. **Binokulær indirekte oftalmoskopi?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

41. **Fundusfotografering?**

❑	❑	❑	❑	❑	❑	❑
0%	< 25%	25-49 %	50 %	51-75 %	> 75 %	100 %

Hvordan anser du din evne til å utføre fundusundersøkelse og vurdere fundus?

42. **Direkte oftalmoskopi** (vanlig oftalmoskopi)

❑	❑	❑	❑	❑	❑
Svært dårlig	Dårlig	Middels	God	Svært god	Har ikke utstyr

43. **Spaltelampe (binokulær) indirekte oftalmoskopi** (Volk linse)

❑	❑	❑	❑	❑	❑
Svært dårlig	Dårlig	Middels	God	Svært god	Har ikke utstyr

44. **Fundusfotografering**

❑	❑	❑	❑	❑	❑
Svært dårlig	Dårlig	Middels	God	Svært god	Har ikke utstyr

45. **Vurdering av fundus**

❑	❑	❑	❑	❑
Svært dårlig	Dårlig	Middels	God	Svært god

De siste spørsmålene, spørsmål 46-51, omfatter samarbeid med annet helsepersonell og rapporterings- og henvisningsrutiner

46. **Dersom du har foretatt en synsundersøkelse av en pasient med diabetes, i hvilke tilfeller sender du rapport til pasientens fastlege?**

❑	❑	❑	❑	❑
Aldri	Ved okulære funn som skyldes diabetes	Avhenger av grad av okulære funn	Alltid	Dersom pasient / fastlege ber om det

47. **I hvilke tilfeller henviser du pasienter med diabetes retinopati til øyelege (via fastlege)?**

❑	❑	❑
Alltid	Dersom pasienten følges opp av øyelege, avhenger det av grad av diabetes retinopati	Avhenger av grad av diabetes retinopati

48. **Hva slags samarbeid har du med fastlegene? (sett gjerne flere kryss)**

- ❑ Har ikke samarbeid
- ❑ Henviser / konfererer per telefon
- ❑ Sender rapporter
- ❑ Sender henvisinger
- ❑ Mottar epikriser
- ❑ Mottar henvisninger
- ❑ Arbeider i praksis sammen med fastleger

49. **Hva slags samarbeid har du med øyeleger? (sett gjerne flere kryss)**

- ❑ Har ikke samarbeid
- ❑ Henviser / konfererer per telefon
- ❑ Sender rapporter
- ❑ Sender henvisinger
- ❑ Mottar epikriser
- ❑ Mottar henvisninger
- ❑ Arbeider i praksis sammen med øyeleger

50. **Hvor mange pasienter med ikke kjent diabetes har du henvist med mistanke om *diabetes retinopati* i løpet av de siste 12 måneder? Antall: _____**

51. **Hvor mange pasienter med ikke kjent diabetes har du henvist med mistanke om *diabetes* i løpet av de siste 12 måneder? Antall: _____**

KOMMENTARER:

☐ **JA, jeg ønsker også å delta i del 2 av undersøkelsen.**

Vennligst kontroller at du har besvart alle spørsmålene.
Postlegg spørreskjemaet i vedlagte returkonvolutt, porto er betalt.

HØGSKOLEN
i Buskerud

Tusen takk for at du tok deg tid til å svare på undersøkelsen!

Appendix 2

IDNR:

DIABETES, SYN OG ØYEHELSE

DIABETES I OPTOMETRISK PRAKSIS - 2

Denne undersøkelsen vil kartlegge forekomsten av diabetes, diabetes retinopati og synshemming i optometrisk praksis, samt omfang av rapporter og henvisning til annet helsepersonell. Kartleggingen vil kunne bli benyttet i utviklingen av diabetesomsorgen i Norge med hensyn til oppfølging av syn og øyehelse.

Kartleggingen er del av doktorgradsprosjektet: DIABETES, SYN OG ØYEHELSE

Undersøkelsen innebærer:
1. å registrere enkelte opplysninger og funn fra de første 20 påfølgende synsundersøkelsene du gjennomfører, del 1 av skjemaet.
2. å registrere enkelte tilleggsopplysninger dersom pasienten har diabetes, eller det sendes rapport eller henvisning til annet helsepersonell, del 2 av skjemaet.

Svarene vil bli behandlet konfidensielt. Undersøkelsen er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS

Pasientinformasjonsskriv til oppslag i praksisen er vedlagt.

Jeg håper du finner tid til å delta i undersøkelsen, nettopp ditt svar er viktig!

Har du spørsmål angående undersøkelsen kontakt:
Vibeke Sundling, Institutt for optometri og synsvitenskap, HiBu, Pb 251, 3601 Kongsberg
Telefon 32 86 97 59, mobil: 924 24 360, e-post: vibeke.sundling@hibu.no

Vennligst returner skjemaet i vedlagte svarkonvolutt innen 17. desember 2004, også dersom skjemaet er utfylt for færre enn 20 synsundersøkelser.

På forhånd takk for hjelpen!

SYNSUNDERSØKELSEN OG DIABETES 2004

Del 1. Vær vennlig og fyll inn opplysninger for de første 20 påfølgende synsundersøkelsene du foretar.

Fyll ut skjemaet ved å sette kryss for funn/undersøkelser som er foretatt og fyll inn opplysninger for visus, trykk og fundusfunn.

Dersom pasienten har diabetes eller henvises, ber vi deg i tillegg om å fylle ut del 2 av skjemaet.

Registreringsperiode:

				til				

Totalt antall undersøkelser i perioden:

	Aldersruppe							Kjønn		Anamnese							Syn / øyehelse										Kommunikasjon			
										Øyesykdom			Generell helse				BCVA (Visus)		IOP (Trykk)		Katarakt		Fundusundersøkelse og funn				Videre oppfølging			
Nr	0-15	16-34	35-44	45-54	55-64	65-74	75+	M	K	Glaukom	Makuladegenerasjon	Katarakt	Diabetes	Høyt blodtrykkk	Hjerte/kar sykdom	Diabetes i familien	Høyre øye (tallverdi)	Venstre øye (tallverdi)	Høyre øye (tallverdi)	Venstre øye (tallverdi)	Høyre øye	Venstre øye	Oftalmoskopi fortatt	Dilatert fundusundersøkelse	Retinopati	Type retinopati (tentativt)	Ingen / Rutineoppfølging	Pasienten kontakter lege	Sendt rapport	Sendt henvisning
1																														
2																														
3																														
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														
13																														
14																														
15																														
16																														
17																														
18																														
19																														
20																														

DEL 2 Dersom pasienten har diabetes eller henvises, ber vi deg i tillegg om å fylle disse opplysningene om pasienten.

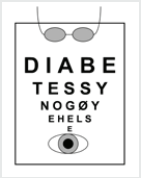
	Diabetesstatus							Syn				Henvisning	
Px	Type	Varighet	Blodsukker (HbA$_1$C)	Blodtrykk	Behandling	Kjent retinopati	Laser-behandlet	Variabel visus	Kjent synshemming	Diplopi	Refraksjon	Mottaker	Årsak
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet

Det er plass til flere på baksiden!

	Diabetesstatus							Syn				Henvisning	
Px	Type	Varighet	Blodsukker (HbA_1C)	Blodtrykk	Behandling	Kjent retinopati	Laser-behandlet	Variabel visus	Kjent synshemming	Diplopi	Refraksjon	Mottaker	Årsak
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet
	❑ type 1 ❑ type 2	_____År	_______ %	❑ for lavt ❑ normalt ❑ for høyt	❑ kost ❑ tabletter ❑ insulin	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ Ja ❑ Nei	❑ tidligere Rx ikke kjent ❑ uendret ❑ myop endring > 1D ❑ hyperop endring > 1D	❑ fastlege ❑ øyelege ❑ legevakten ❑ andre	❑ visus ❑ samsyn ❑ intraokulært trykk ❑ fremre segment ❑ retinopati ❑ makulopati ❑ hodepine ❑ annet

Når skjemaet er ferdig utfylt – vennligst returer det til: Vibeke Sundling, Institutt for optometri og synsvitenskap, Høgskolen i Buskerud, Postboks 251, 3601 Kongsberg
Vennligst returner skjemaet innen 17. desember, også dersom skjemaet er utfylt for færre enn 20 synsundersøkelser. På forhånd – tusen takk for hjelpen!
Har du spørsmål – kontakt Vibeke Sundling, telefon 32 86 97 59, mobil: 924 24 360, e-post: vibeke.sundling@hibu.no

Appendix 3



DIABETES, SYN OG ØYEHELSE

Du er blitt spurt om å delta i denne spørreundersøkelsen fordi du har diabetes (sukkersyke). Diabetes kan, som du kanskje vet, skade øynene og synet. Denne undersøkelsen vil kartlegge syn og helse hos pasienter med diabetes. Kartleggingen kan bli benyttet som grunnlag for å bedre diabetesomsorgen i Norge.

Kartleggingen er en del av doktorgradsprosjektet: DIABETES, SYN OG ØYEHELSE

Har du spørsmål angående undersøkelsen kontakt:
Stipendiat Vibeke Sundling
Institutt for optometri og synsvitenskap, Høgskolen i Buskerud
Telefon 32 86 97 59, mobil: 924 24 360, e-post: vibeke.sundling@hibu.no

All informasjon vil bli behandlet konfidensielt.

Prosjektet er tilråd av den regionale komité for medisinsk forskningsetikk.

Deltagelse i undersøkelsen er frivillig.

Du vil ikke kunne identifiseres i publikasjoner fra studiet.

Det tar kun noen minutter å fylle ut skjemaet.
Det utfylte spørreskjemaet returneres i vedlagte frankerte svarkonvolutt.

1. **Kjønn**

Kvinne ☐
Mann ☐

2. **Fødselsår**

1	9		

3. **Bostedfylke**

_____

4. **Hvilken type diabetes har du?**

Type 1 ☐
Type 2 ☐
Annen ☐
Usikker ☐

5. **Hvilket årstall fikk du diabetes?**

1	9		

Spørsmål 5 – 13 omhandler undersøkelse av øyehelse og syn. Når vi spør om du regelmessig går til undersøkelse, mener vi om du undersøkes jevnlig f.eks. årlig, halvårlig, eller månedlig. I spørsmålene skiller vi også mellom:

1. Øyeundersøkelse -
   Undersøkelse av øyebunn / netthinne
2. Synsundersøkelse –
   Undersøkelse av hvor godt du ser

5. **Når ble den første øyeundersøkelsen foretatt etter at du fikk diagnosen diabetes?**

Innen 1 år ☐
I løpet av 1- 5 år ☐
Etter mer enn 5 år ☐
Ikke undersøkt ☐
Usikker ☐

6. **Går du til regelmessig øyeundersøkelse på grunn av din diabetes?**

Ja ☐
Nei ☐

7. **Blir det foretatt øyeundersøkelse ved kontroll hos fastlege?**

Ja ☐
Nei ☐

8. **Går du regelmessig til synsundersøkelse hos:**

	JA	NEI
Optiker	☐	☐
Øyelege	☐	☐
Annen lege	☐	☐
Annet helsepersonell	☐	☐
Synsundersøkes ikke	☐	

Dersom du går regelmessig til øyeundersøkelse ber vi deg om å besvare spørsmål 9- 11. Hvis du ikke går til regelmessig øyeundersøkelse gå videre til spørsmål 12.

9. **Hvor lenge er det vanligvis mellom hver gang du er til øyeundersøkelse?**

_____ måneder

_____ år

10. **Hvordan blir øyeundersøkelsen foretatt?**

	JA	NEI
Fotografering	☐	☐
Undersøkelse av øyelege	☐	☐
Undersøkelse av fastlege	☐	☐
Undersøkelse av optiker	☐	☐
Usikker / vet ikke	☐	

11. **Hvor fornøyd er du med øyeundersøkelsen / oppfølgingen av øynene?**

Svært godt fornøyd ☐
Godt fornøyd ☐
Middels fornøyd ☐
Lite fornøyd ☐
Svært lite fornøyd ☐

Dersom du går til regelmessig synsundersøkelse hos optiker ber vi deg om å besvare spørsmål 12-13. Hvis du ikke går til regelmessig synsundersøkelse hos optiker gå videre til spørsmål 14.

12. **Hvor lenge er det vanligvis mellom hver gang du er til synsundersøkelse?**

_____ måneder

_____ år

13. **Hvor fornøyd er du med synsundersøkelsen / oppfølgingen av synet?**

- Svært godt fornøyd ☐
- Godt fornøyd ☐
- Middels fornøyd ☐
- Lite fornøyd ☐
- Svært lite fornøyd ☐

Spørsmål 14 –21 omhandler synshjelpemidler, syn og øyehelse.

14. **Bruker du følgende synshjelpemidler ?**

	JA	NEI
Avstandsbriller / Gåbriller	☐	☐
Lesebriller / Databriller	☐	☐
Bifokale / Progressive briller	☐	☐
Kontaktlinser	☐	☐
Lupe / lupebrille / lese-TV	☐	☐

15. **Har du problemer med synet, som lege har sagt skyldes diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

16. **Har du fått behandling av øynene som følge av øyeforandringer som skyldes diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

17. **Har du noen kjent øyesykdom?**

	JA	NEI
Øyeforandring pga diabetes	☐	☐
Øyeforandring pga blodpropp / høyt blodtrykk	☐	☐
Forkalkning på netthinnen	☐	☐
Grønn stær / høyt øyetrykk	☐	☐
Grå stær	☐	☐
Annen øyesykdom	☐	☐

18. **Har du i løpet av det siste året opplevd synsforstyrrelser som:**

	JA	NEI
Uklart syn	☐	☐
Variabelt syn	☐	☐
Flekker i synsfeltet	☐	☐
Deler i synsfeltet forsvinner	☐	☐
Dobbelt syn	☐	☐
Rette linjer er bølgede	☐	☐
Andre symptomer	☐	☐

19. **Dersom du har opplevd synsforstyrrelser, forsvinner disse ved bruk av briller eller kontaktlinser?**

- Ja ☐
- Nei ☐

20. **Hvem ville du oppsøke først dersom du merket forandringer med synet?**
Sett ev. flere kryss

- Lege ☐
- Optiker ☐
- Øyelege / øyeavd. sykehus ☐
- Usikker ☐

21. **Har du fått informasjon om å undersøke synet og øynene regelmessig fordi du har diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

22. **Dersom du har fått informasjon om å undersøke synet og øynene regelmessig, hvor har du fått denne informasjonen?**

	JA	NEI
Fastlege (ev. vikar)	☐	☐
Øyelege	☐	☐
Annen lege	☐	☐
Optiker	☐	☐
Sykehus	☐	☐
Diabeteskurs	☐	☐
Brosjyrer / " Diabetes "	☐	☐
Aviser/Ukeblader/Radio/TV	☐	☐
Andre som har diabetes	☐	☐
Annet	☐	☐

Spørsmål 22-29 omhandler behandling av diabetes og generell helse.

23. **Hvordan behandles din diabetes nå?**

	JA	NEI
Kost	☐	☐
Mosjon	☐	☐
Slanking/vektreduksjon	☐	☐
Tabletter	☐	☐
Insulin	☐	☐

24. **Hva var langtidsblodsukkeret ditt ($HbA1_c$) ved siste kontroll?**

_____ %

Usikker ☐

25. **Har blodsukkeret ditt vært stabilt det siste året?**

Ja ☐
Nei ☐
Usikker ☐

26. **Hva var blodtrykket ditt ved siste måling hos lege?**

Overtrykk _____ mmHg

Undertrykk _____ mmHg

Usikker ☐

27. **Bruker du blodtrykksregulerende medisiner?**

Ja ☐
Nei ☐
Usikker ☐

28. **Bruker du kolesterolsenkende medisiner?**

Ja ☐
Nei ☐
Usikker ☐

29. **Røyker du?**

Ja ☐
Nei ☐

Antall sigaretter per dag: _____

30. **Har du røkt tidligere?**

Ja ☐
Nei ☐

KOMMENTARER:

Vennligst kontroller at du har besvart alle spørsmålene.

Tusen takk for at du tok deg tid til å svare på undersøkelsen!

Appendix 4

DIABETES, SYN OG ØYEHELSE

Du er blitt spurt om å delta i denne spørreundersøkelsen fordi du har diabetes (sukkersyke), og deltok i Glukosebelastningsprosjektet (GLUP) i Verdal i fjor. Diabetes kan, som du kanskje vet, skade øynene og synet. Denne undersøkelsen vil kartlegge syn og helse hos pasienter med diabetes. Kartleggingen kan bli benyttet som grunnlag for å bedre diabetesomsorgen i Norge.

Har du spørsmål angående undersøkelsen kontakt:
Stipendiat Vibeke Sundling, Institutt for optometri og synsvitenskap, Høgskolen i Buskerud
Telefon 32 86 97 59, mobil: 924 24 360, e-post: vibeke.sundling@hibu.no

Deltagelse i undersøkelsen er frivillig.

All informasjon vil bli behandlet konfidensielt.

Det utfylte spørreskjemaet tar du med til syn- og øyeundersøkelsen ved HUNT.

1. **Kjønn**

Kvinne ☐
Mann ☐

2. **Fødselsår**

1	9		

3. **Hvilken type diabetes har du?**

Type 1 ☐
Type 2 ☐
Annen ☐
Usikker ☐

4. **Hvilket årstall fikk du diabetes?**

1	9		

Spørsmål 5 – 13 omhandler undersøkelse av øyehelse og syn. Når vi spør om du regelmessig går til undersøkelse, mener vi om du undersøkes jevnlig f.eks. årlig, halvårlig, eller månedlig. I spørsmålene skiller vi også mellom:

1. Øyeundersøkelse - Undersøkelse av øyebunn / netthinne
2. Synsundersøkelse – Undersøkelse av hvor godt du ser

5. **Når ble den første øyeundersøkelsen foretatt etter at du fikk diagnosen diabetes?**

Innen 1 år ☐
I løpet av 1- 5 år ☐
Etter mer enn 5 år ☐
Ikke undersøkt ☐
Usikker ☐

6. **Går du til regelmessig øyeundersøkelse på grunn av din diabetes?**

Ja ☐
Nei ☐

7. **Blir det foretatt øyeundersøkelse ved kontroll hos fastlege?**

Ja ☐
Nei ☐

8. **Går du regelmessig til synsundersøkelse hos:**

	JA	NEI
Optiker	☐	☐
Øyelege	☐	☐
Annen lege	☐	☐
Annet helsepersonell	☐	☐
Synsundersøkes ikke	☐	

Dersom du går regelmessig til øyeundersøkelse ber vi deg om å besvare spørsmål 9- 11. Hvis du ikke går til regelmessig øyeundersøkelse gå videre til spørsmål 12.

9. **Hvor lenge er det vanligvis mellom hver gang du er til øyeundersøkelse?**

_____ måneder

_____ år

10. **Hvordan blir øyeundersøkelsen foretatt?**

	JA	NEI
Fotografering	☐	☐
Undersøkelse av øyelege	☐	☐
Undersøkelse av fastlege	☐	☐
Undersøkelse av optiker	☐	☐
Usikker / vet ikke	☐	

11. **Hvor fornøyd er du med øyeundersøkelsen / oppfølgingen av øynene?**

Svært godt fornøyd ☐
Godt fornøyd ☐
Middels fornøyd ☐
Lite fornøyd ☐
Svært lite fornøyd ☐

Dersom du går til regelmessig synsundersøkelse hos optiker ber vi deg om å besvare spørsmål 12-13. Hvis du ikke går til regelmessig synsundersøkelse hos optiker gå videre til spørsmål 14.

12. **Hvor lenge er det vanligvis mellom hver gang du er til synsundersøkelse?**

_____ måneder

_____ år

13. **Hvor fornøyd er du med synsundersøkelsen / oppfølgingen av synet?**

- Svært godt fornøyd ☐
- Godt fornøyd ☐
- Middels fornøyd ☐
- Lite fornøyd ☐
- Svært lite fornøyd ☐

Spørsmål 14 –21 omhandler synshjelpemidler, syn og øyehelse.

14. **Bruker du følgende synshjelpemidler ?**

	JA	NEI
Avstandsbriller / Gåbriller	☐	☐
Lesebriller / Databriller	☐	☐
Bifokale / Progressive briller	☐	☐
Kontaktlinser	☐	☐
Lupe / lupebrille / lese-TV	☐	☐

15. **Har du problemer med synet, som lege har sagt skyldes diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

16. **Har du fått behandling av øynene som følge av øyeforandringer som skyldes diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

17. **Har du noen kjent øyesykdom?**

	JA	NEI
Øyeforandring pga diabetes	☐	☐
Øyeforandring pga blodpropp / høyt blodtrykk	☐	☐
Forkalkning på netthinnen	☐	☐
Grønn stær / høyt øyetrykk	☐	☐
Grå stær	☐	☐
Annen øyesykdom	☐	☐

18. **Har du i løpet av det siste året opplevd synsforstyrrelser som:**

	JA	NEI
Uklart syn	☐	☐
Variabelt syn	☐	☐
Flekker i synsfeltet	☐	☐
Deler i synsfeltet forsvinner	☐	☐
Dobbelt syn	☐	☐
Rette linjer er bølgede	☐	☐
Andre symptomer	☐	☐

19. **Dersom du har opplevd synsforstyrrelser, forsvinner disse ved bruk av briller eller kontaktlinser?**

- Ja ☐
- Nei ☐

20. **Hvem ville du oppsøke først dersom du merket forandringer med synet?**
Sett ev. flere kryss

- Lege ☐
- Optiker ☐
- Øyelege / øyeavd. sykehus ☐
- Usikker ☐

21. **Har du fått informasjon om å undersøke synet og øynene regelmessig fordi du har diabetes?**

- Ja ☐
- Nei ☐
- Usikker ☐

22. **Dersom du har fått informasjon om å undersøke synet og øynene regelmessig, hvor har du fått denne informasjonen?**

	JA	NEI
Fastlege (ev. vikar)	☐	☐
Øyelege	☐	☐
Annen lege	☐	☐
Optiker	☐	☐
Sykehus	☐	☐
Diabeteskurs	☐	☐
Brosjyrer / " Diabetes "	☐	☐
Aviser/Ukeblader/Radio/TV	☐	☐
Andre som har diabetes	☐	☐
Annet	☐	☐

Spørsmål 22-29 omhandler behandling av diabetes og generell helse.

23. **Hvordan behandles din diabetes nå?**

	JA	NEI
Kost	☐	☐
Mosjon	☐	☐
Slanking/vektreduksjon	☐	☐
Tabletter	☐	☐
Insulin	☐	☐

24. **Hva var langtidsblodsukkeret ditt ($HbA1_c$) ved siste kontroll?**

_____ %

Usikker ☐

25. **Har blodsukkeret ditt vært stabilt det siste året?**

Ja ☐
Nei ☐
Usikker ☐

26. **Hva var blodtrykket ditt ved siste måling hos lege?**

Overtrykk _____ mmHg

Undertrykk _____ mmHg

Usikker ☐

27. **Bruker du blodtrykksregulerende medisiner?**

Ja ☐
Nei ☐
Usikker ☐

28. **Bruker du kolesterolsenkende medisiner?**

Ja ☐
Nei ☐
Usikker ☐

29. **Røyker du?**

Ja ☐
Nei ☐

Antall sigaretter per dag: _____

30. **Har du røkt tidligere?**

Ja ☐
Nei ☐

KOMMENTARER:

Vennligst kontroller at du har besvart alle spørsmålene.

Tusen takk for at du tok deg tid til å svare på undersøkelsen!

Appendix 5

ID:

REGISTRERINGSSKJEMA
GLUP 2 – SYN

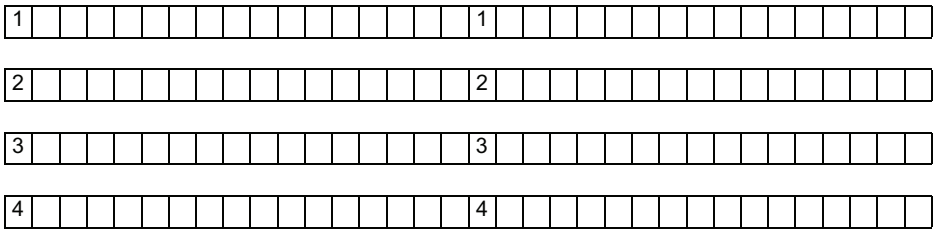
1 Anamnese

1.1	Kjønn	☐ Kvinne ☐ Mann		
1.2	Fødselsår	19		
1.3	Symptomer	☐ Uklart syn ☐ Variablet syn ☐ Flekker i synsfeltet ☐ Deler av synsfeltet forsvinner ☐ Dobbelt syn ☐ Rette linjer er bølgende ☐ Lysømfintlig		
1.4	Forsvinner ved bruk av briller eller kontaktlinser	☐ Ja ☐ Nei		
1.5	Synshjelpemidler	☐ Avstandsbriller / gåbriller ☐ Lesebriller / databriller ☐ Bifokale / progressivebriller ☐ Kontaktlinser ☐ Lupe / lupebrille / lesetv		
1.6	Regelmessig synsundersøkelse	☐ Ja ☐ Nei	☐ Optiker ☐ Øyelege	/12
1.7	Regelmessig øyeundersøkelse	☐ Ja ☐ Nei	☐ Optiker ☐ Øyelege	/12
1.8	Øyesykdommer	☐ Diabetes retinopati ☐ Annen retinopati ☐ Makuladegenerasjon ☐ Glaukom ☐ Katarakt ☐ Annen		
1.9	Diabetes	☐ Ja ☐ Nei		
1.10	Diabetes i familien	☐ Ja ☐ Nei		
1.11	Hjerte / Karsykdom	☐ Ja ☐ Nei		
1.12	Blodtrykk	☐ Lavt ☐ Normalt ☐ Høyt ☐ Usikker	/	mmHg

2 Okulær helse

2.1	Tonometri	OD	OS	TID
		_____ mmHg	_____ mmHg	_____.

2.2 Fundusfoto



		OD	OS
2.2.1	Dilateres	☐ Ja ☐ Nei	☐ Ja ☐ Nei
2.3.1	Fundusvurdering	☐ Normal ☐ Unormal	☐ Normal ☐ Unormal
2.3.2	Diabetes retinopati	☐ Ja ☐ Nei	☐ Ja ☐ Nei
2.3.3	Gradering diabetes retinopati	☐ Ingen ☐ Mild NPDR ☐ Moderat NPDR ☐ Alvorlig NPDR ☐ PDR ☐ Makulaødem	☐ Ingen ☐ Mild NPDR ☐ Moderat NPDR ☐ Alvorlig NPDR ☐ PDR ☐ Makulaødem
2.4	Katarakt	OD ☐ Ja ☐ Nei	OS ☐ Ja ☐ Nei

2.5 Kommentarer:

3 Synsfunksjon

		OD	OS	OU
3.1	Habituell korreksjon	/ x	/ x	
3.2	Habituell visus			
3.3	Refraksjon	/ x	/ x	
3.4	Beste korrigerte visus			
3.5	Visus med hullblende			
3.6	Add			

3.7 Refraksjons endring

☐ Tidligere Rx ikke kjent
☐ Uendret
☐ Myop endring > 1D
☐ Hyperop endring > 1D

3.8 Covertest

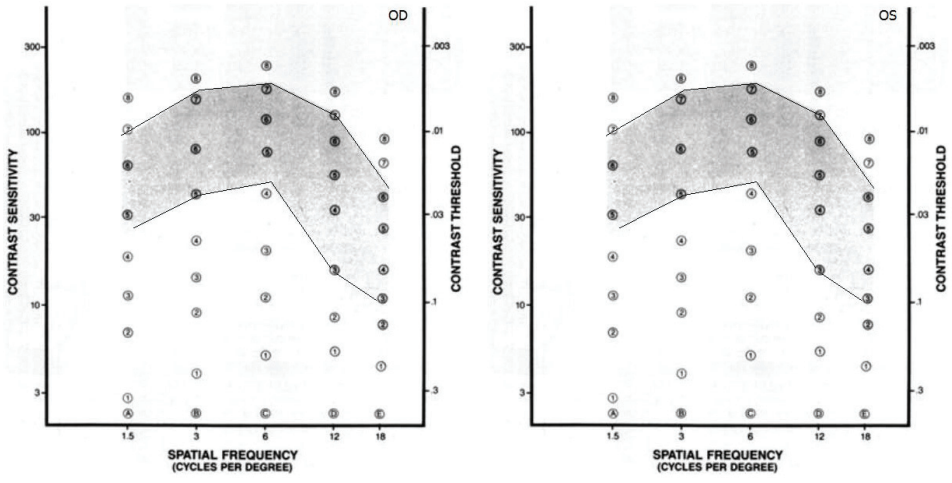
☐ Orto	☐ Exo	Δ
☐ Fori	☐ Eso	
☐ Tropi	☐ Hyper	OD/OD/ALT

3.9 Synsfelt - Amsler

OD	OS
☐ Normalt	☐ Normalt
☐ Synsfeltutfall	☐ Synsfeltutfall

3.10 Kontrastfølsomhet

OD	OS
☐ Normalt	☐ Normalt
☐ Redusert	☐ Redusert



4 Videre håndtering og oppfølging

4.1	Brilleseddel utlevert	☐ Ja ☐ Nei	
4.2	Henvises	☐ Ja ☐ Nei	☐ Fastlege ☐ Øyelege ☐ Øyeblikkelig hjelp
4.3	Henvisningsårsak		☐ Visus ☐ Samsyn ☐ Intraokulært trykk ☐ Fremre segment ☐ Retinopati ☐ Makulopati ☐ Hodepine ☐ Annet

5 Kommentarer:

Dato:

Signatur:

Appendix 6

FUNDUSFOTOVURDERING – GLUP2

1. Surname (id): **16**

2. Alder: **36**

		Høyre øye	Venstre øye
3.1	Netthinnevurdering	☐ Normal ☐ Unormal ☐ For dårlig billedkvalitet	☐ Normal ☐ Unormal ☐ For dårlig billedkvalitet
3.2	Retinopati	☐ Ingen ☐ Diabetes ☐ Hypertensjon ☐ Annen vaskulær ☐ AMD ☐ Annen	☐ Ingen ☐ Diabetes ☐ Hypertensjon ☐ Annen vaskulær ☐ AMD ☐ Annen
3.3	Diabetes retinopati	☐ Ingen DR ☐ Mild NPDR ☐ Moderat NPDR ☐ Alvorlig NPDR ☐ PDR ☐ Laserbehandlet DR	☐ Ingen DR ☐ Mild NPDR ☐ Moderat NPDR ☐ Alvorlig NPDR ☐ PDR ☐ Laserbehandlet DR
3.4	Papillevurdering	☐ Normal ☐ Unormal	☐ Normal ☐ Unormal

4. Merknader:

Dato:

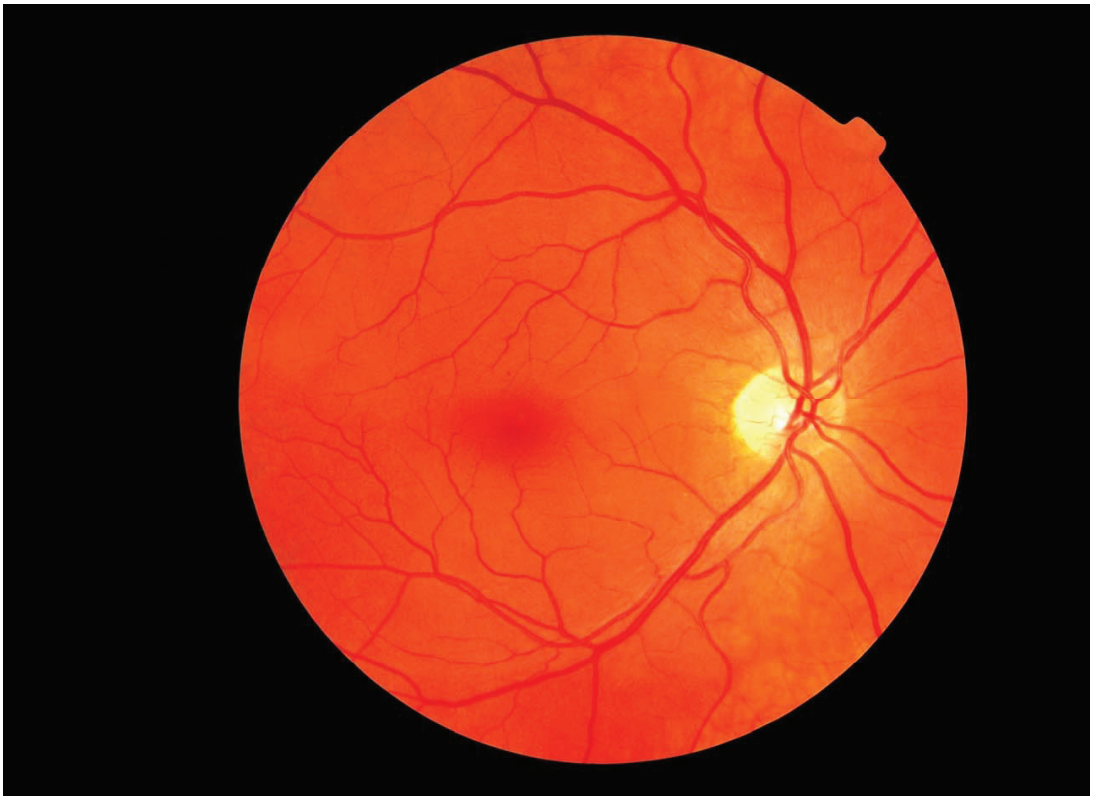
Signatur:

Appendix 7

Vurdering av diabetes retinopati

Medlemsnummer i NOF:

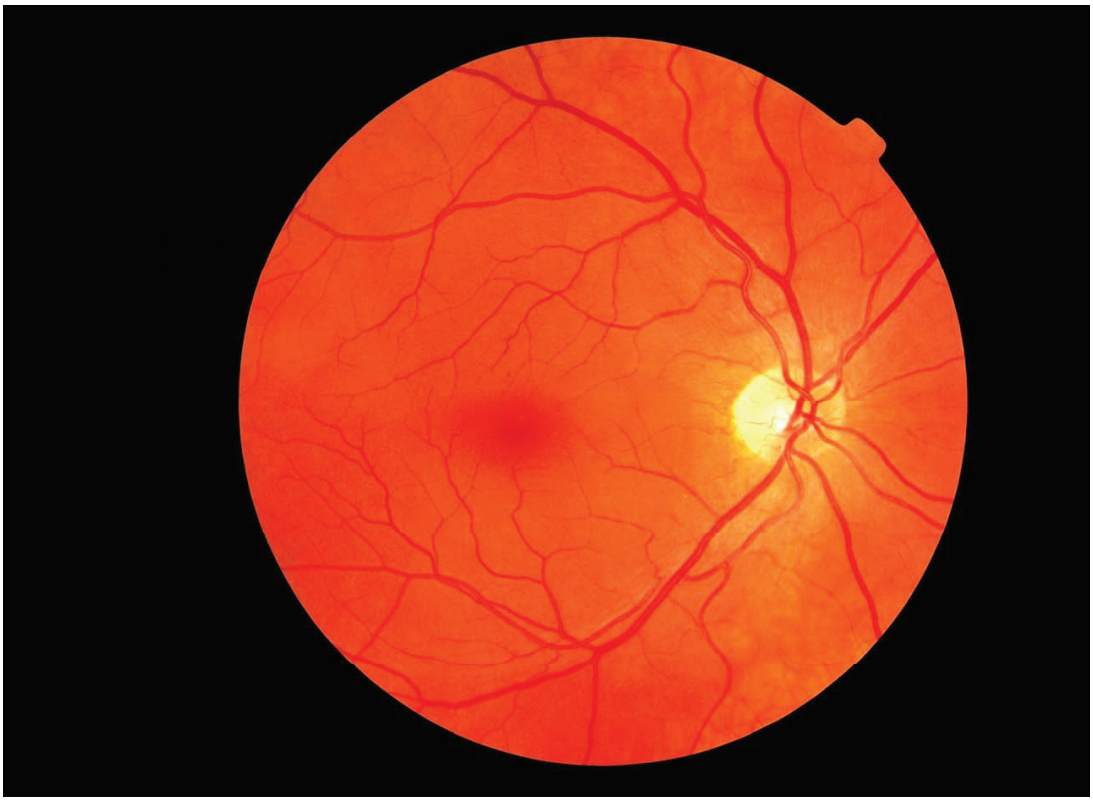
Legg inn ditt medlemsnummer i NOF som brukernavn
(Medlemsnummeret finner du i e-posten, 5 siffer)



Bilde nr 1, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

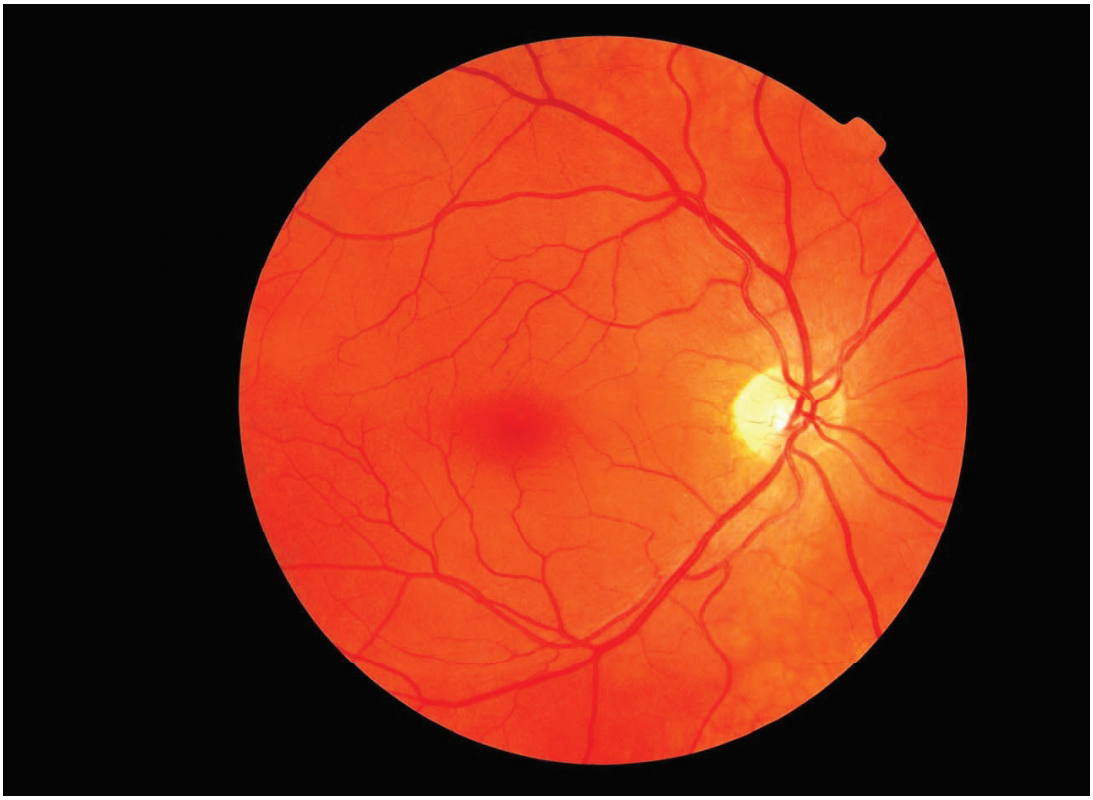


Bilde nr 1, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- ☐ Ingen retinopati
- ☐ Mikroaneurysmer
- ☐ Blødninger
- ☐ Harde eksudater
- ☐ Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- ☐ Venøs kaliberveksling
- ☐ IRMA (intraretinale mikrovaskulære abnormaliteter)
- ☐ Neovaskularisering
- ☐ Andre funn / annen tentativ diagnose

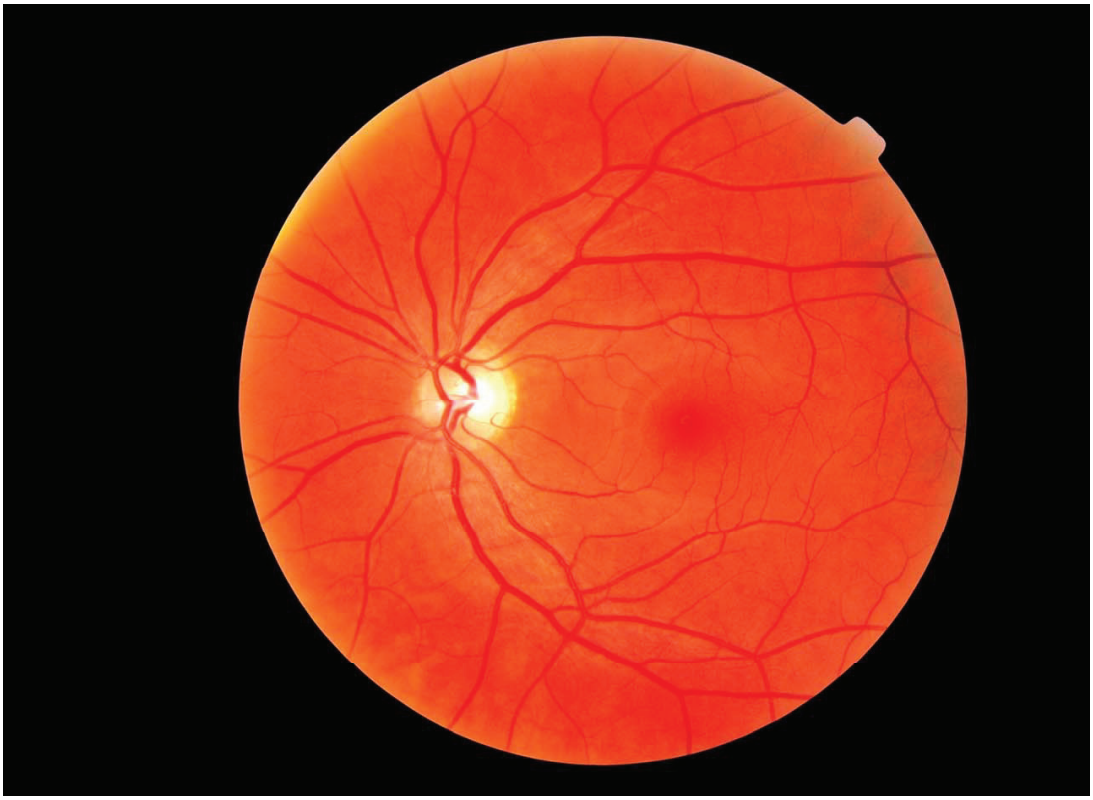


Bilde 1, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

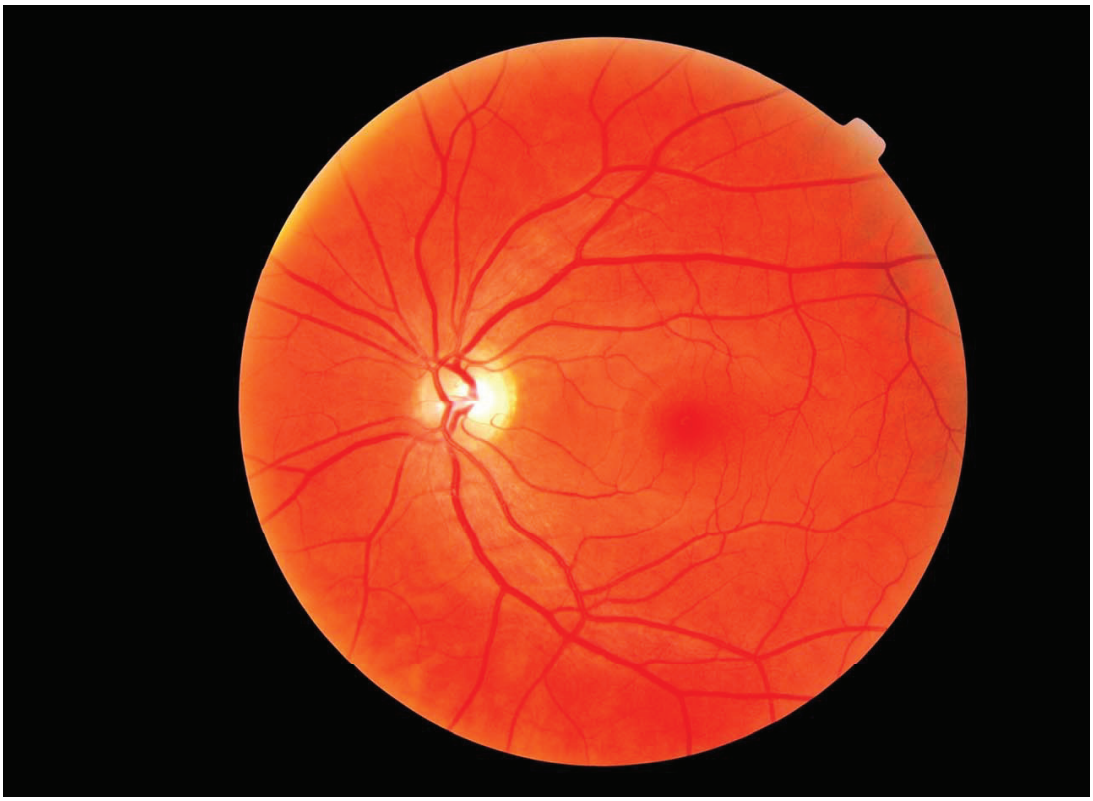
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 2, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

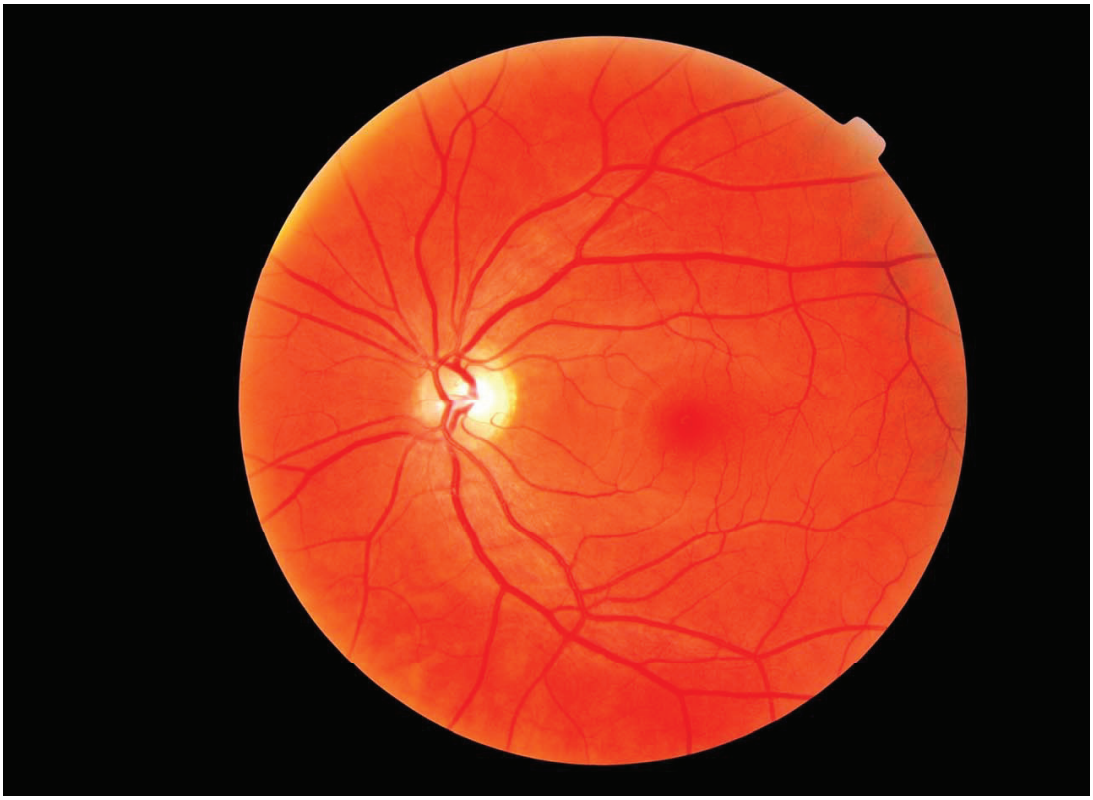


Bilde nr 2, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- ☐ Ingen retinopati
- ☐ Mikroaneurysmer
- ☐ Blødninger
- ☐ Harde eksudater
- ☐ Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- ☐ Venøs kaliberveksling
- ☐ IRMA (intraretinale mikrovaskulære abnormaliteter)
- ☐ Neovaskularisering
- ☐ Andre funn / annen tentativ diagnose

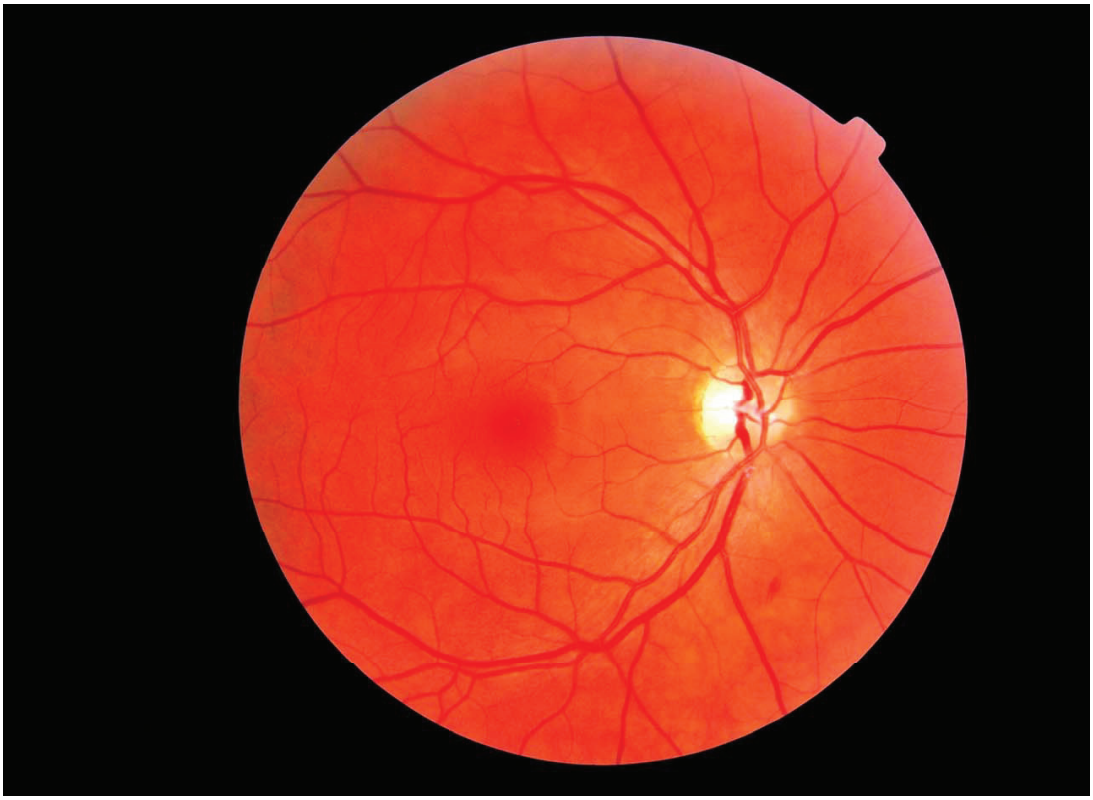


Bilde 2, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

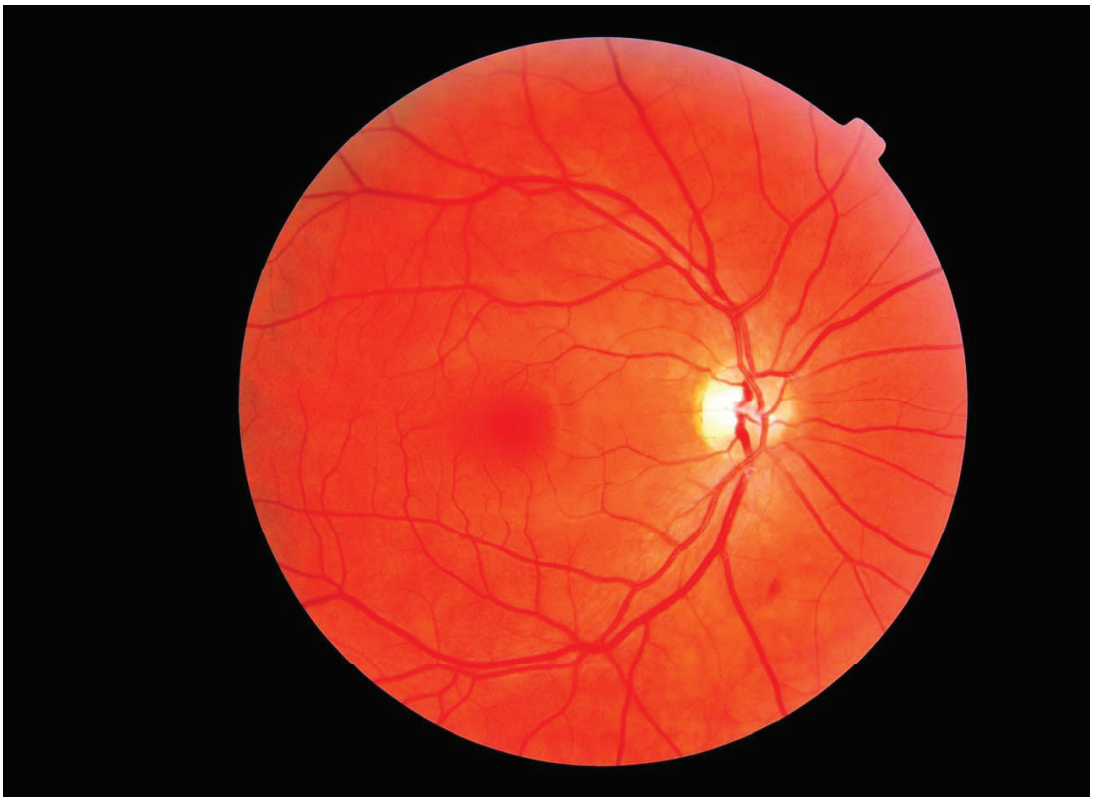
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 3, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

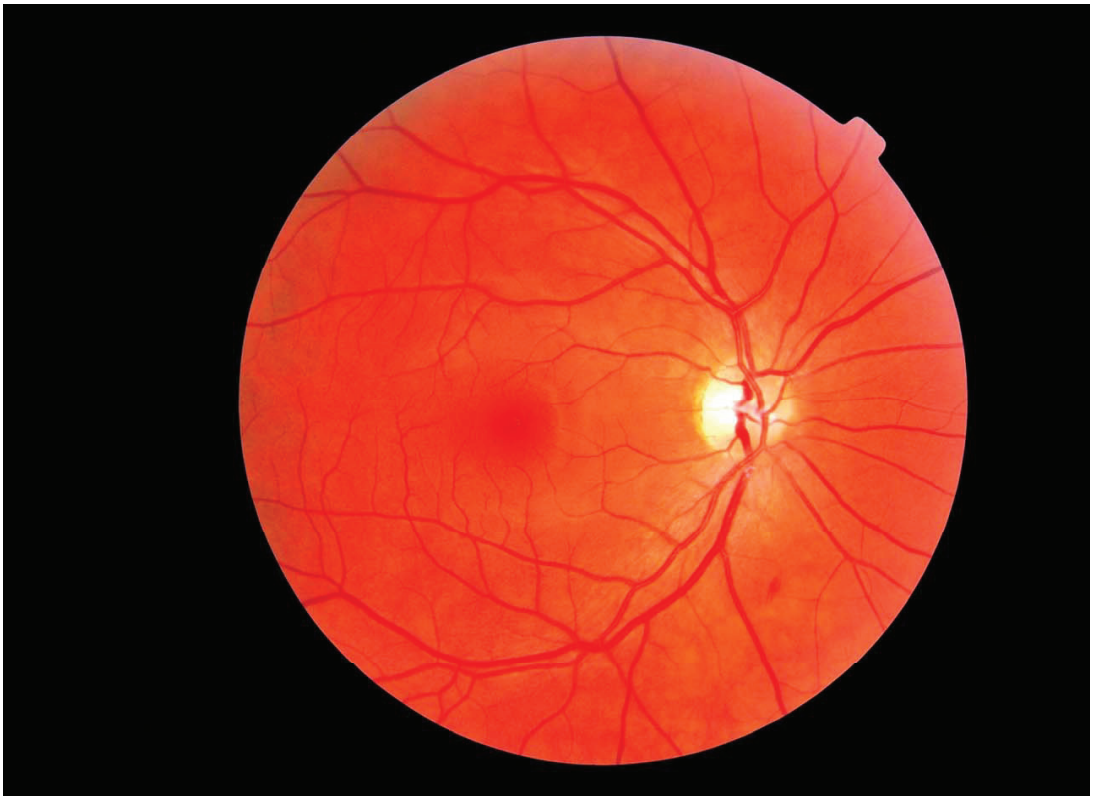


Bilde nr 3, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

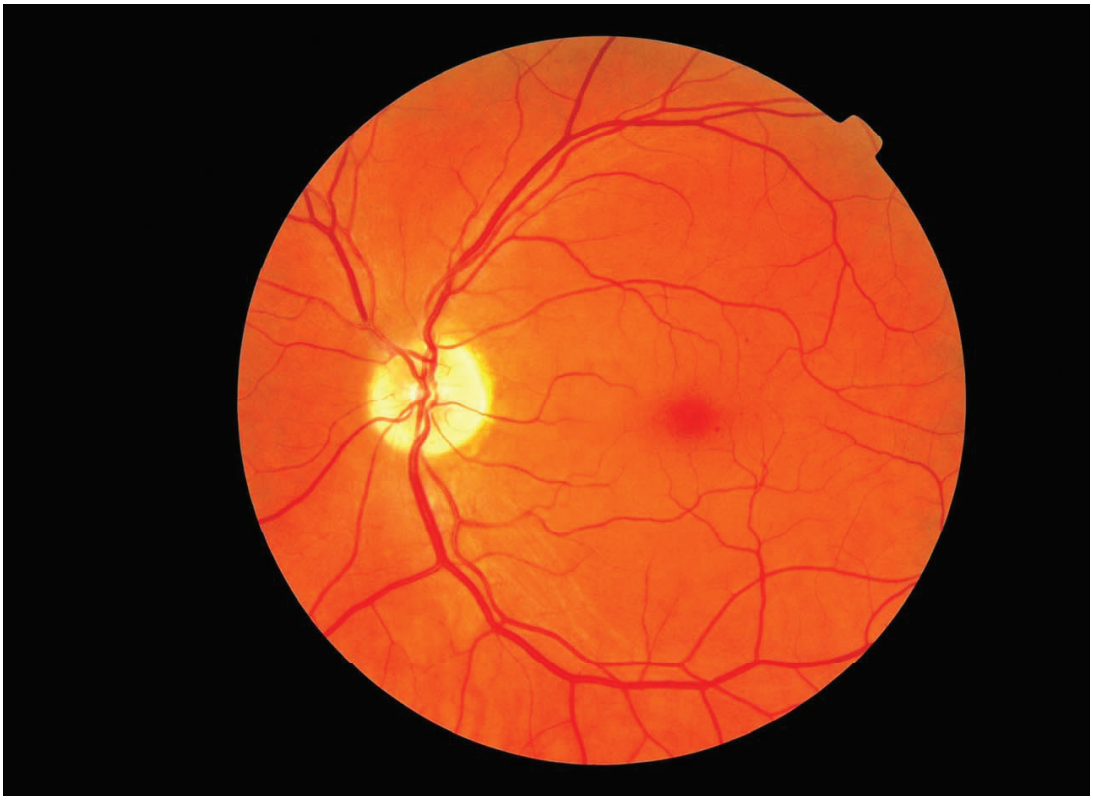


Bilde 3, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

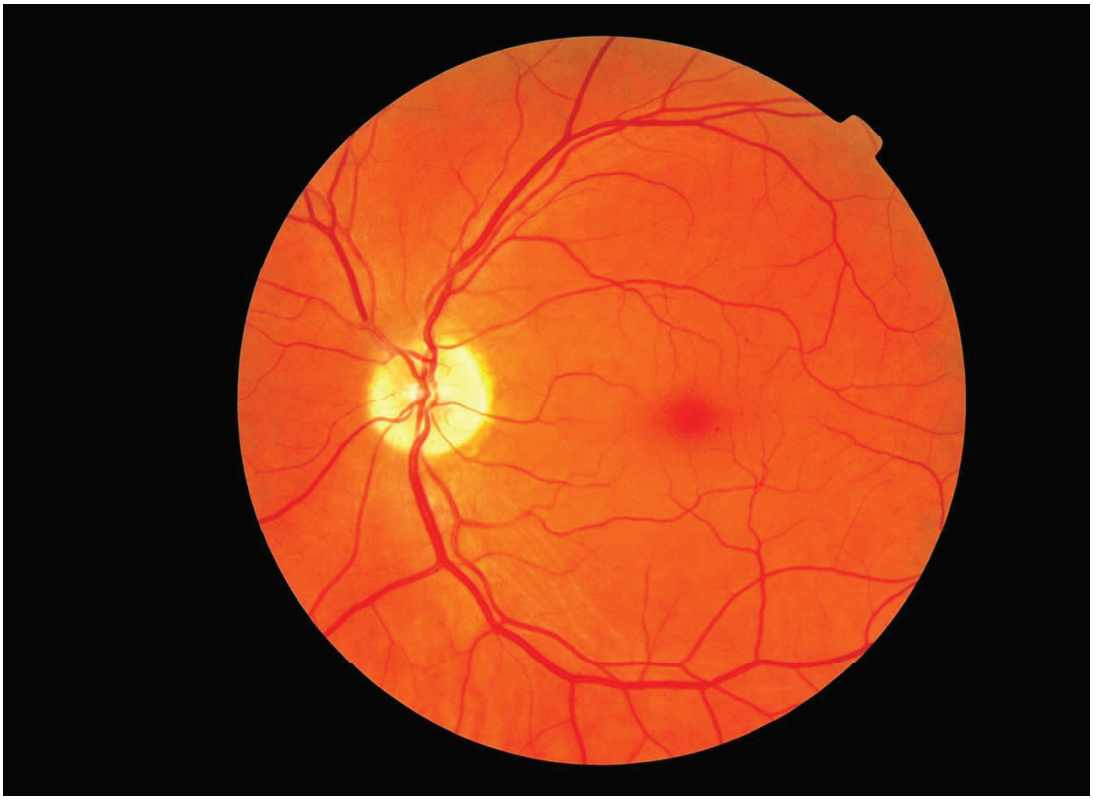
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 4, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

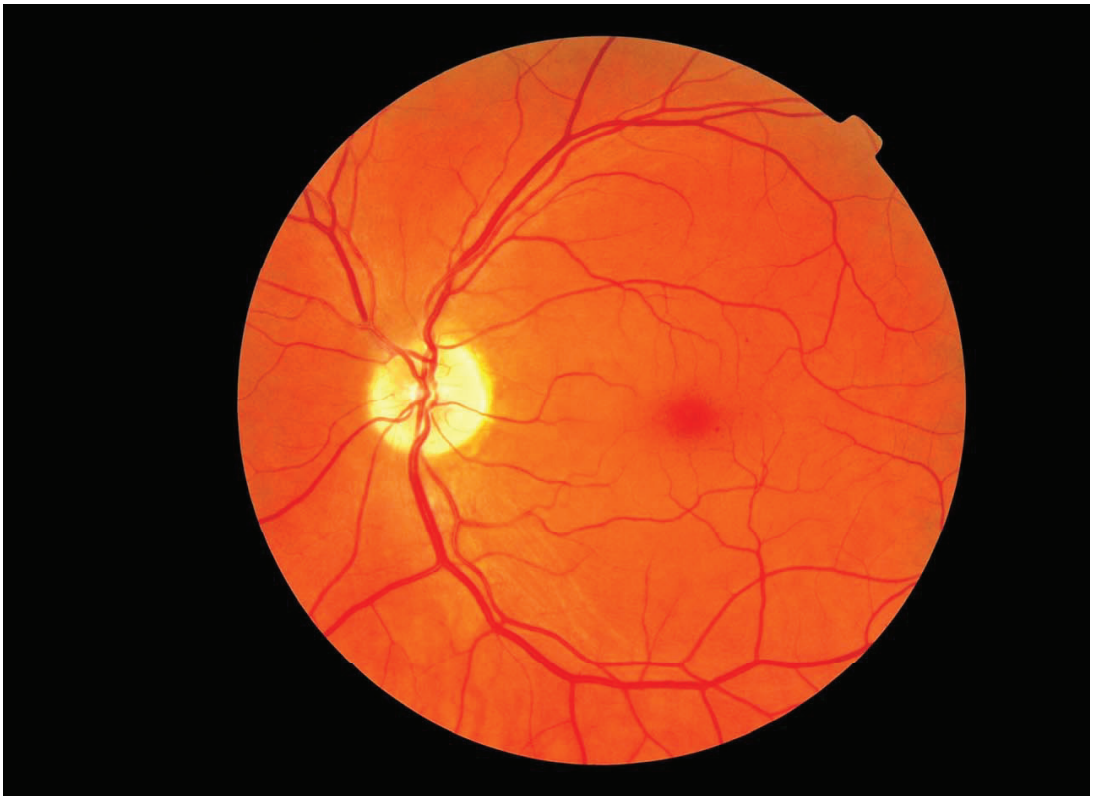


Bilde nr 4, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

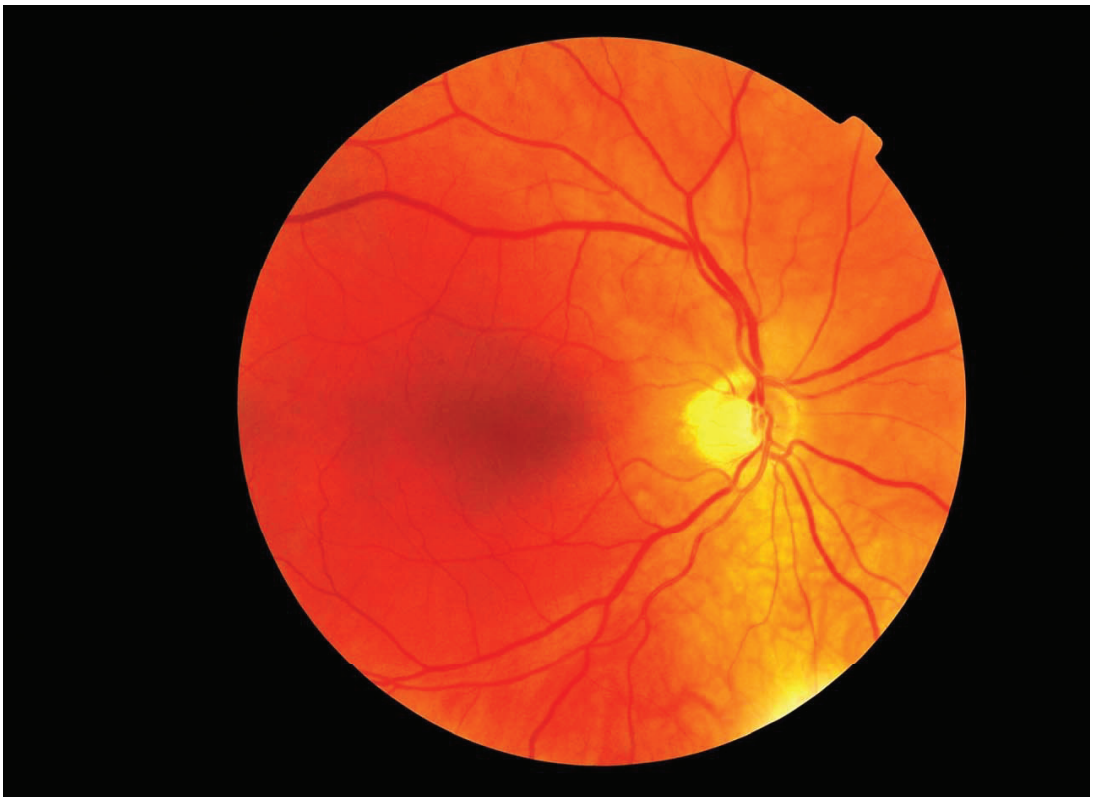


Bilde 4, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

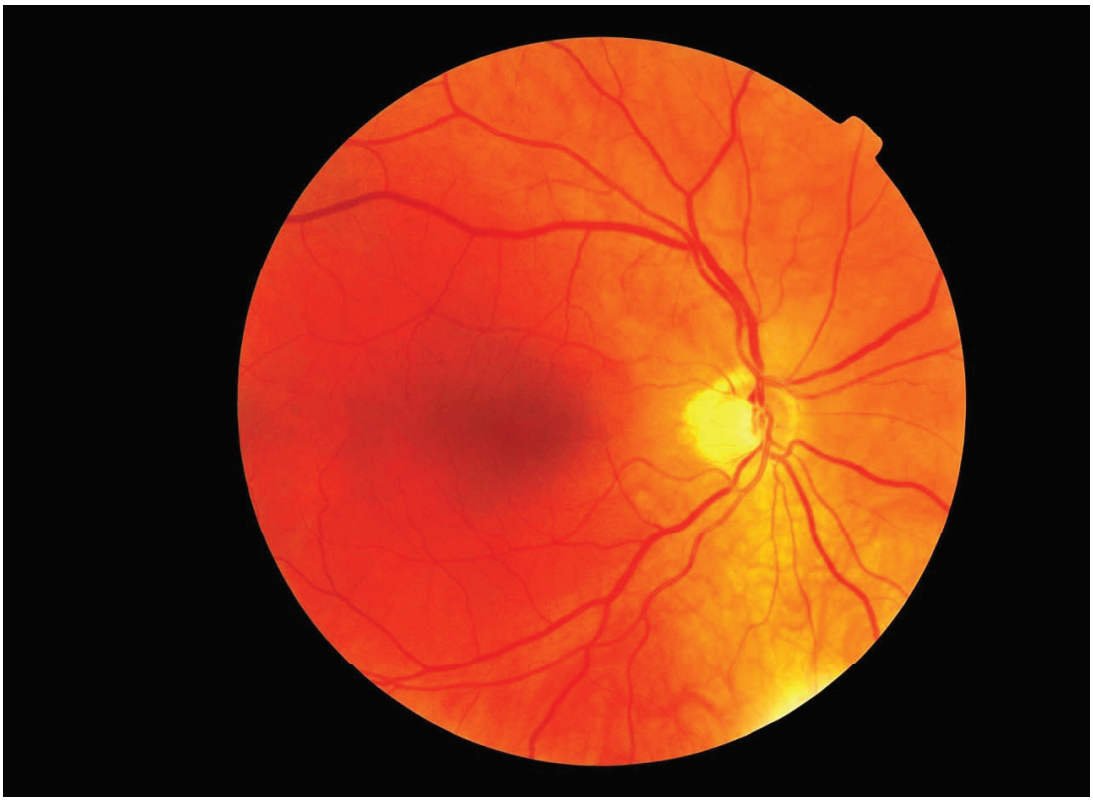
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 5, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

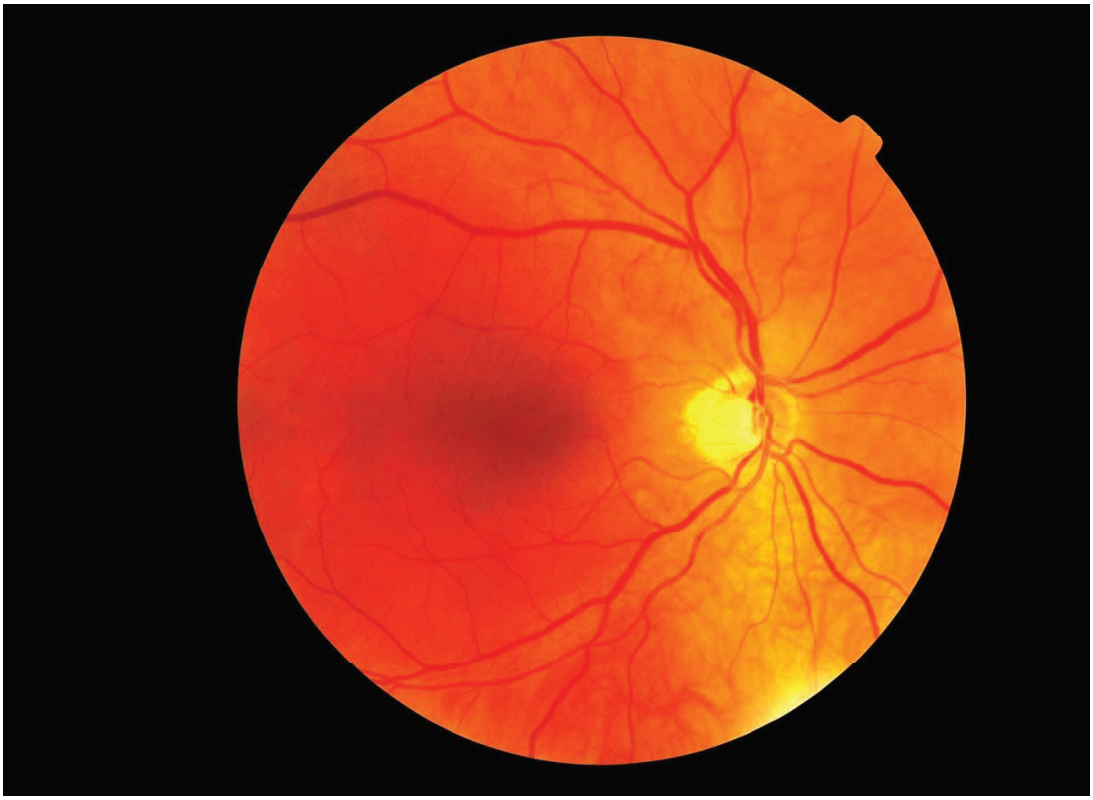


Bilde nr 5, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

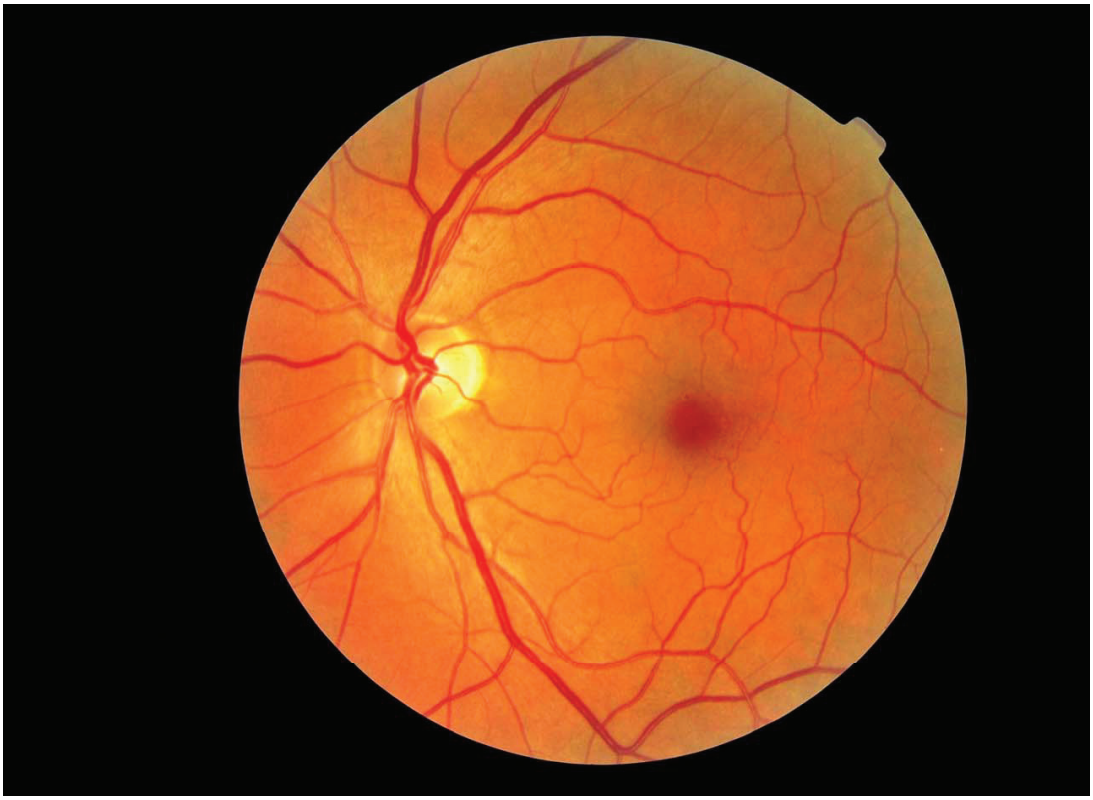


Bilde 5, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

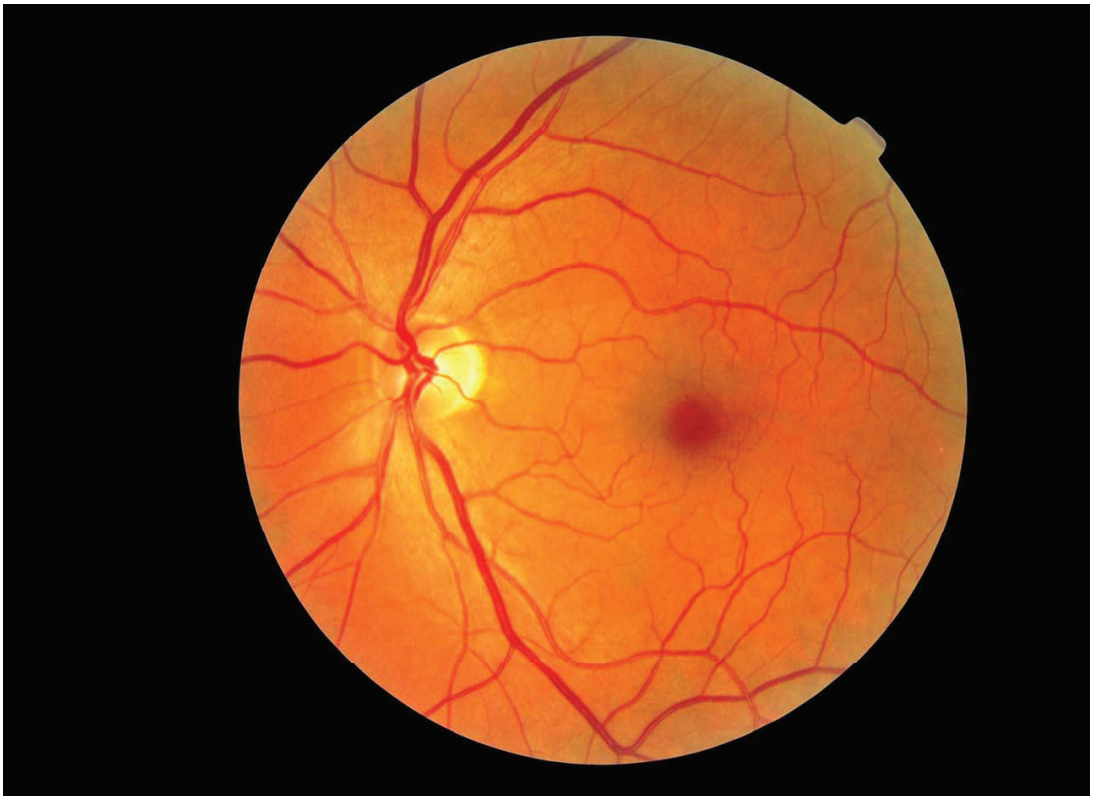
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 6, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

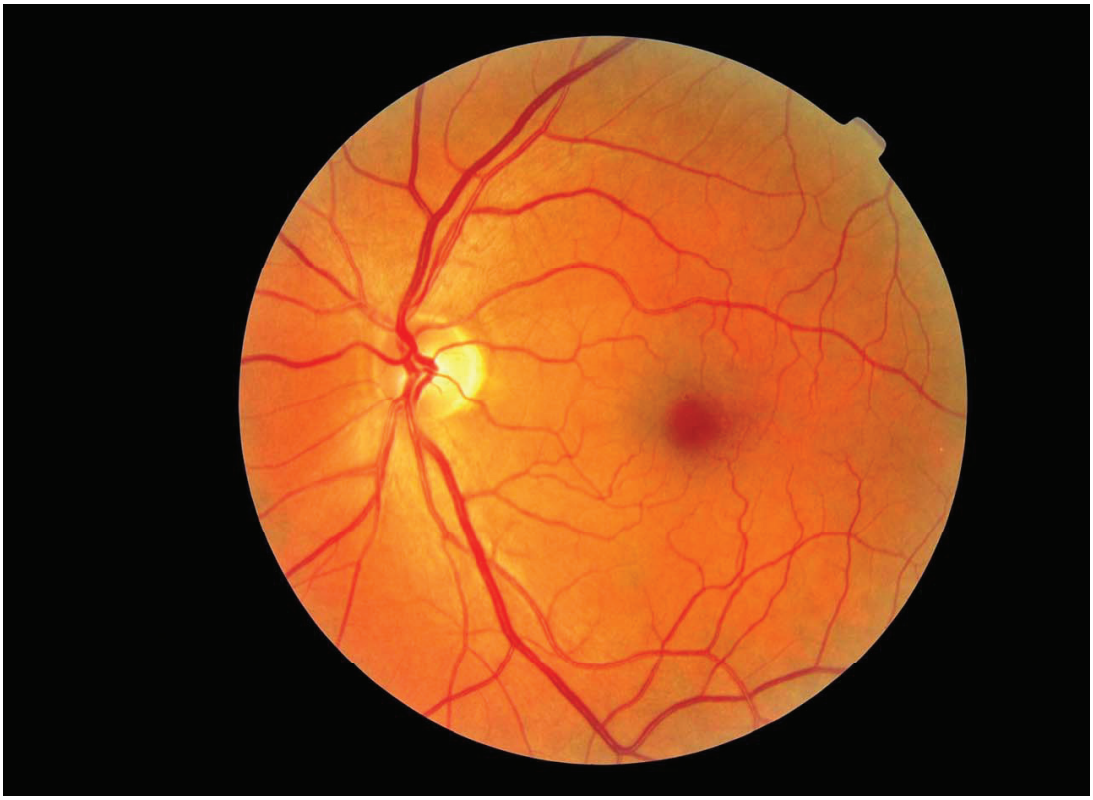


Bilde nr 6, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

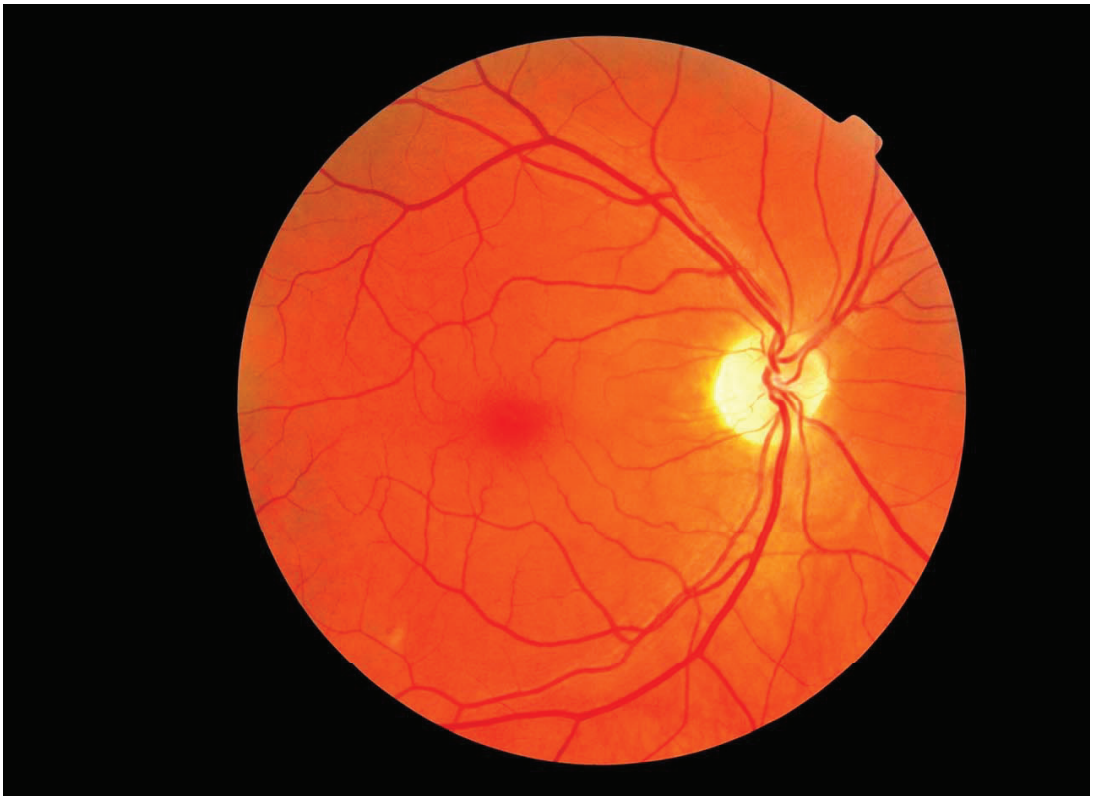


Bilde 6, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

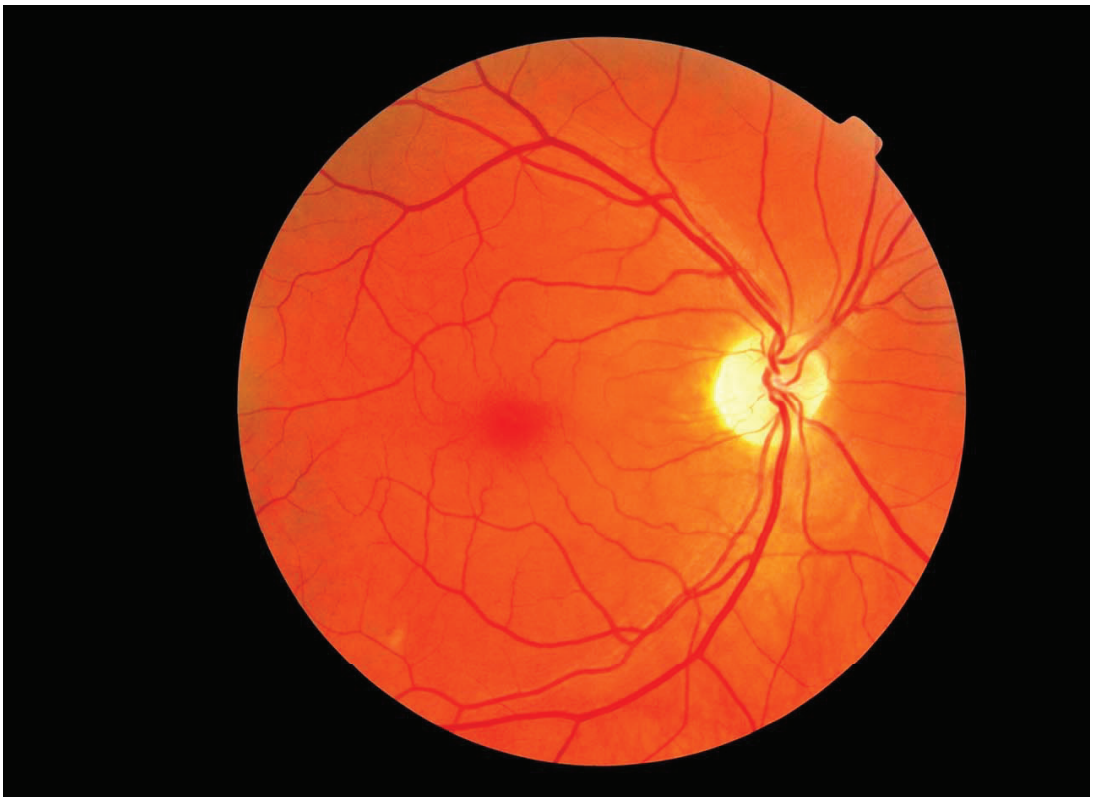
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 7, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

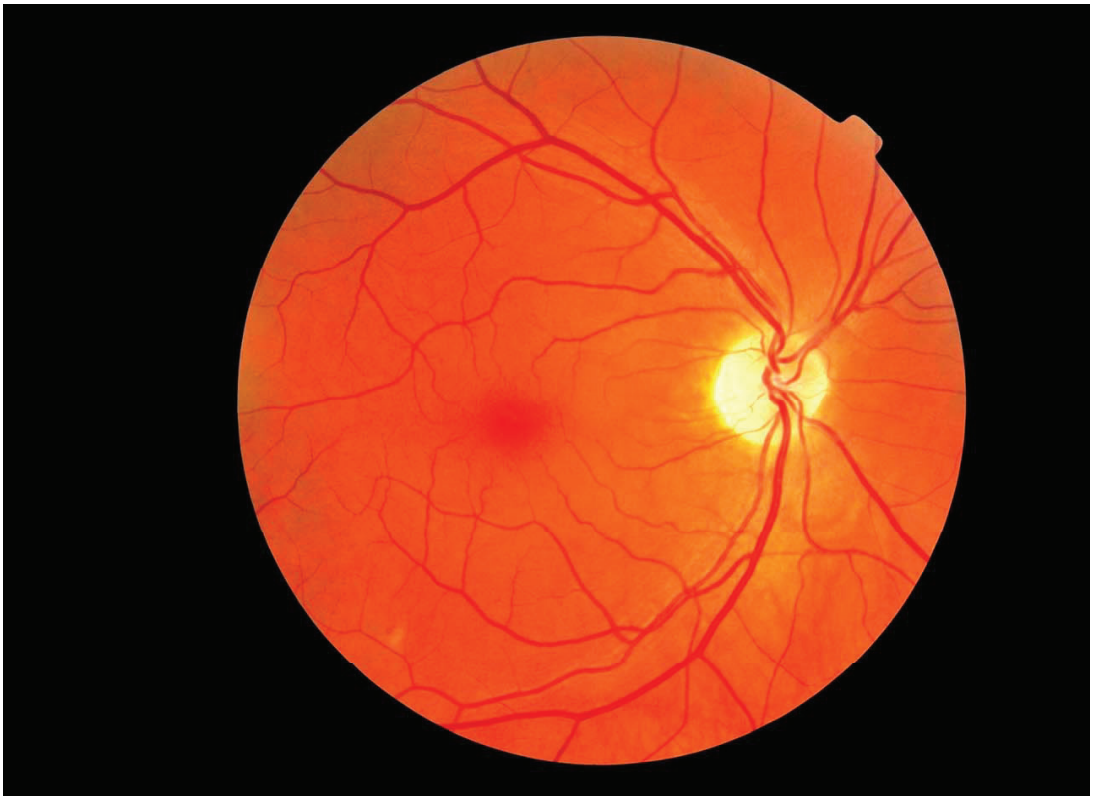


Bilde nr 7, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

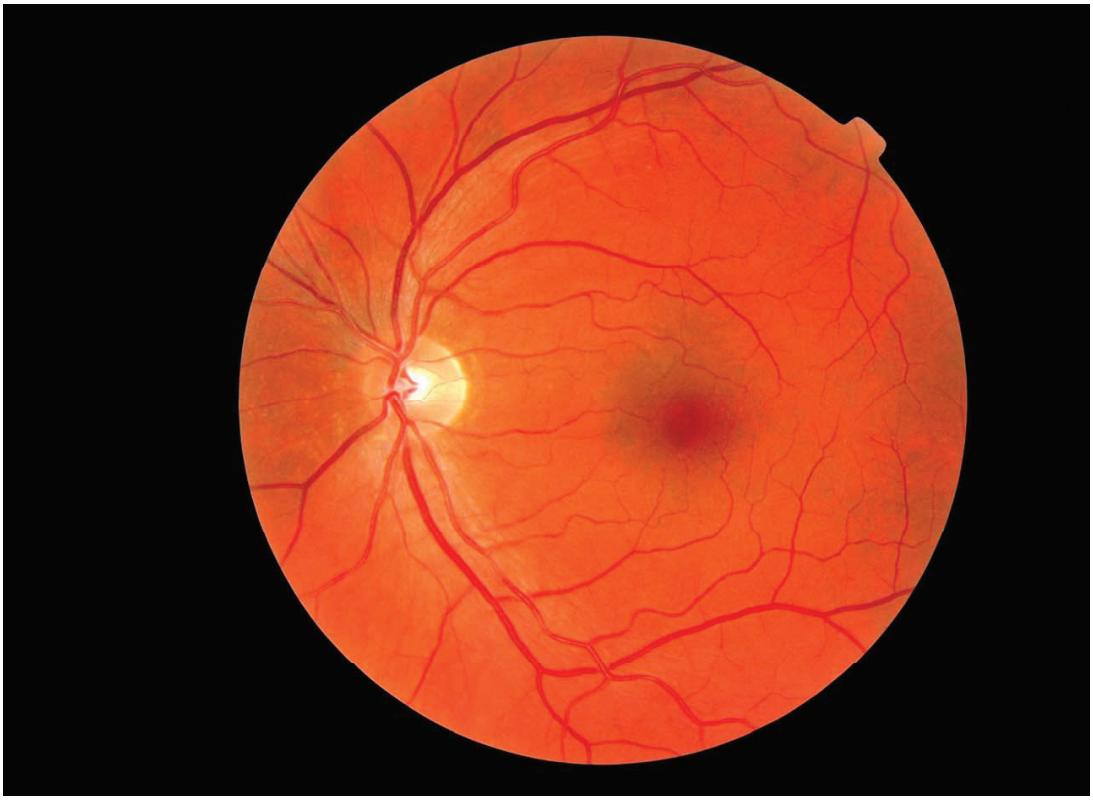


Bilde 7, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

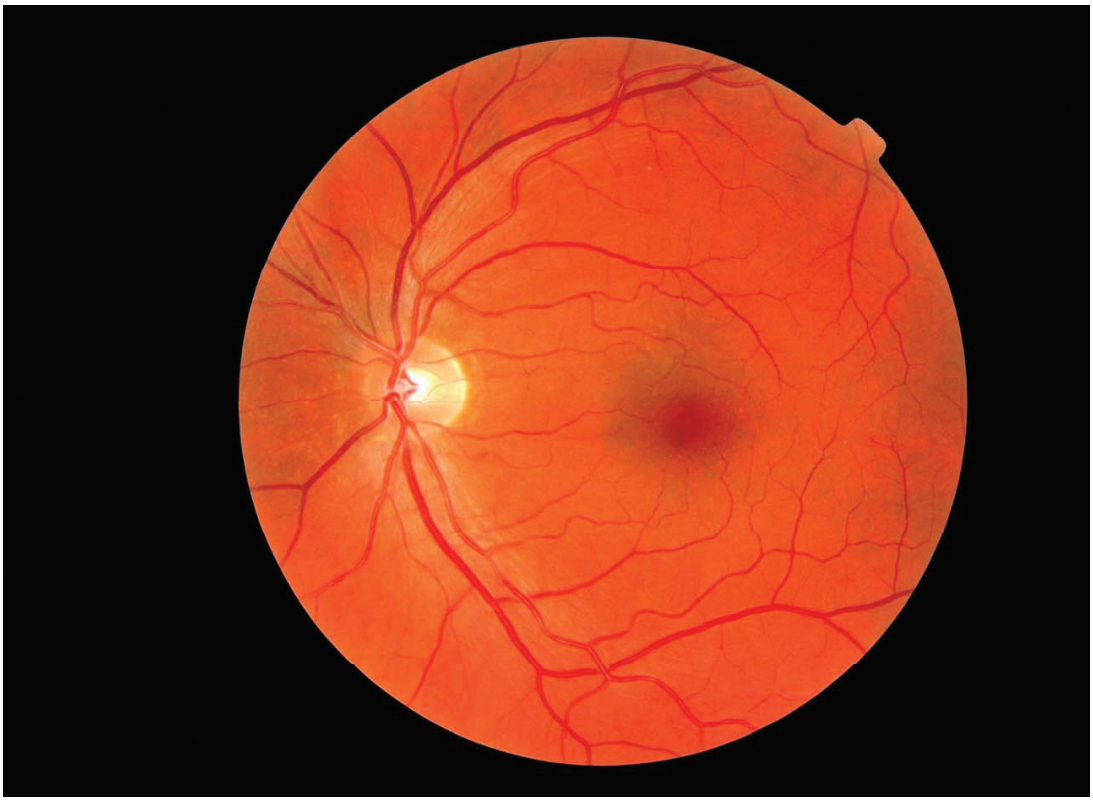
- 0 Ingen videre oppfølging / Rutineoppfølging
- 0 Rapport til fastlege
- 0 Henvising til fastlege
- 0 Henvising til øyelege



Bilde nr 8, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

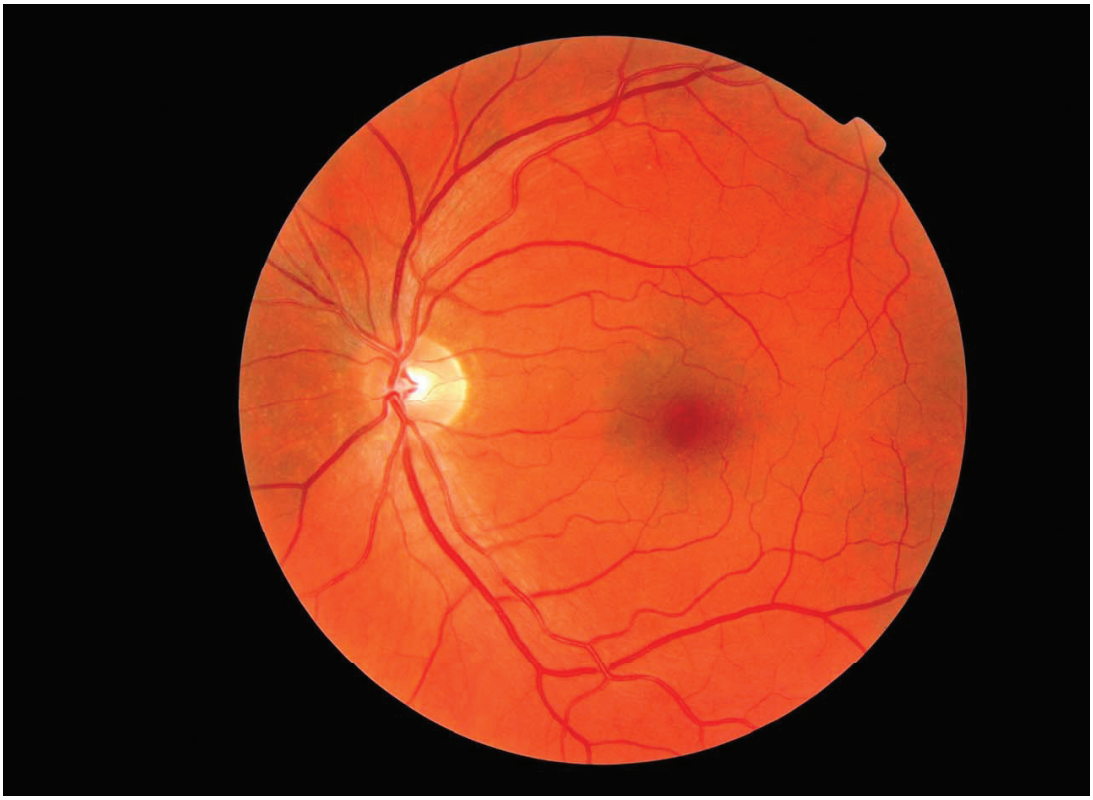


Bilde nr 8, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

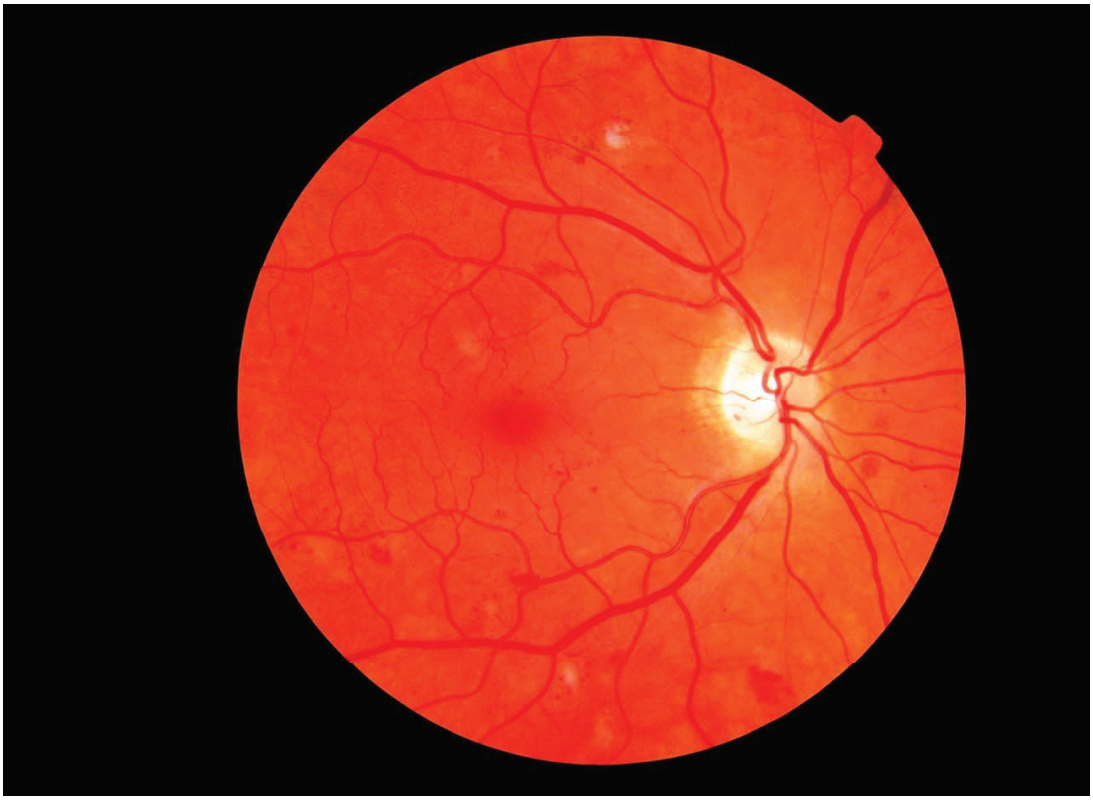


Bilde 8, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

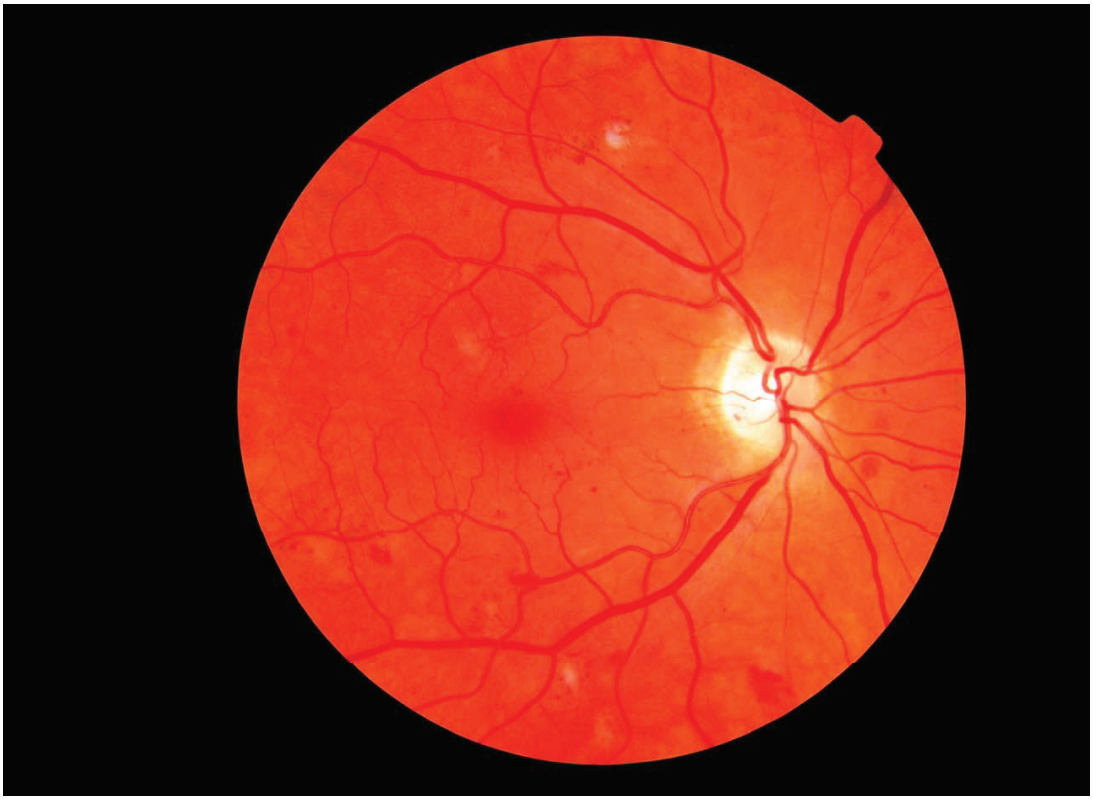
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 9, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

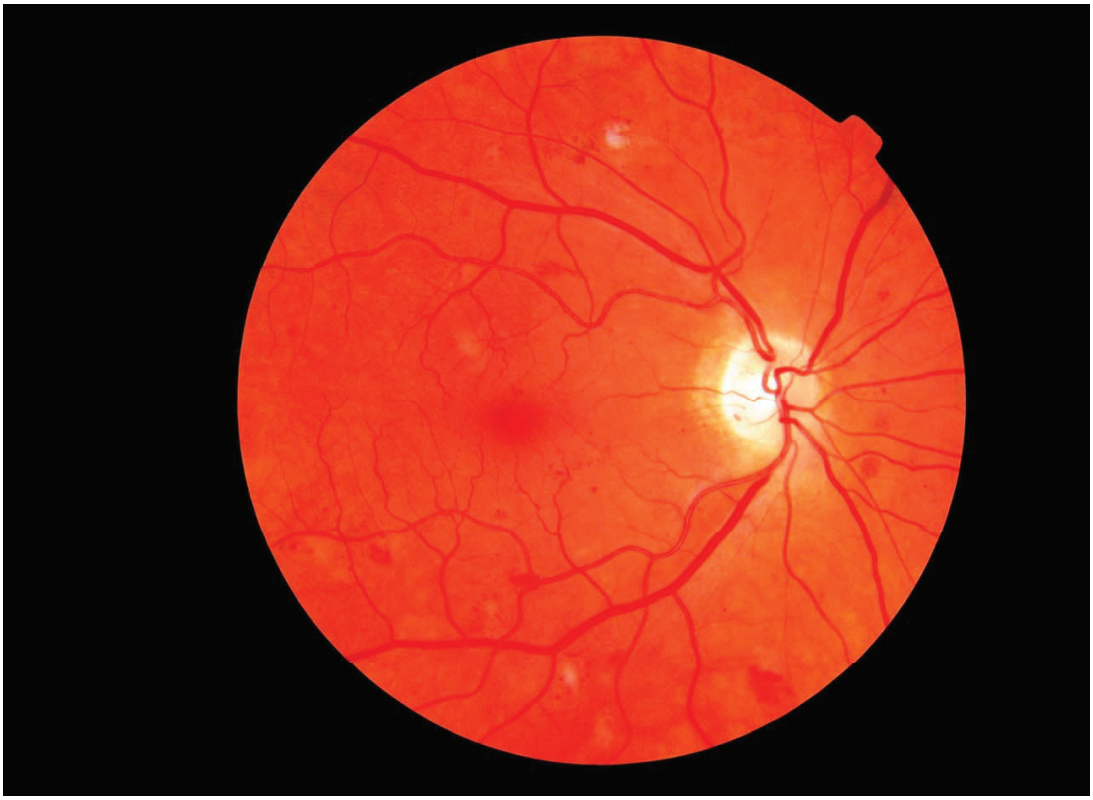


Bilde nr 9, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

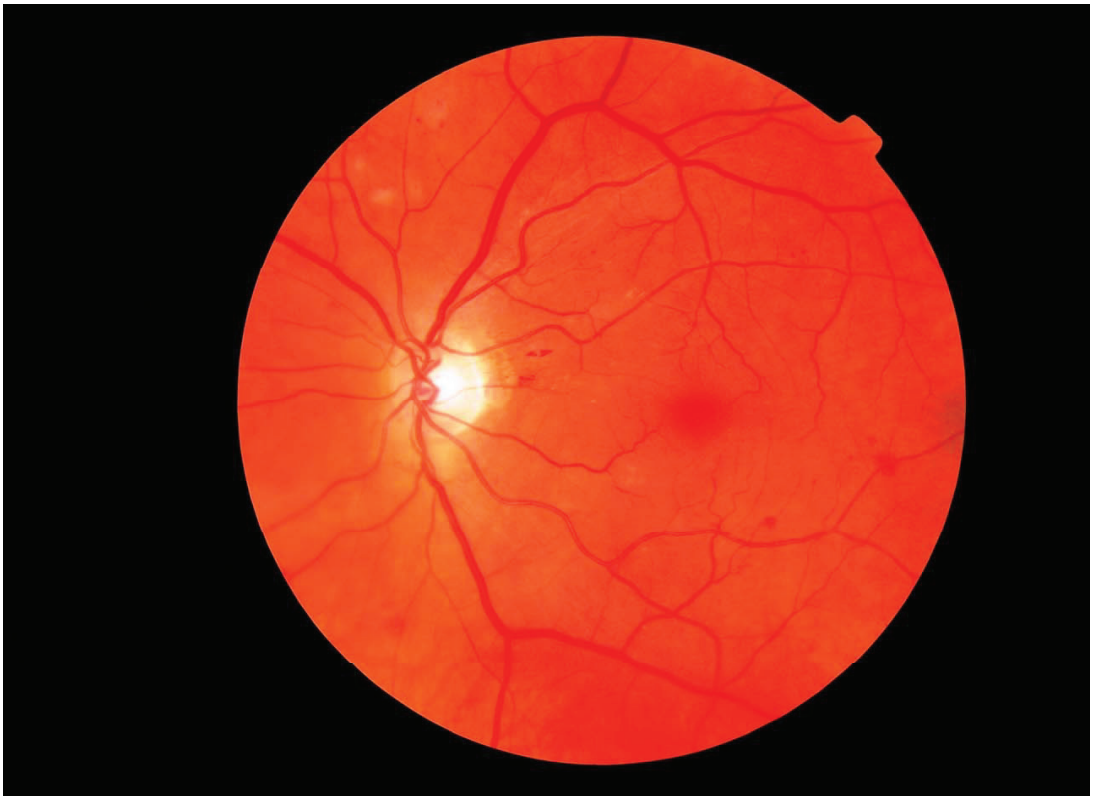


Bilde 9, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

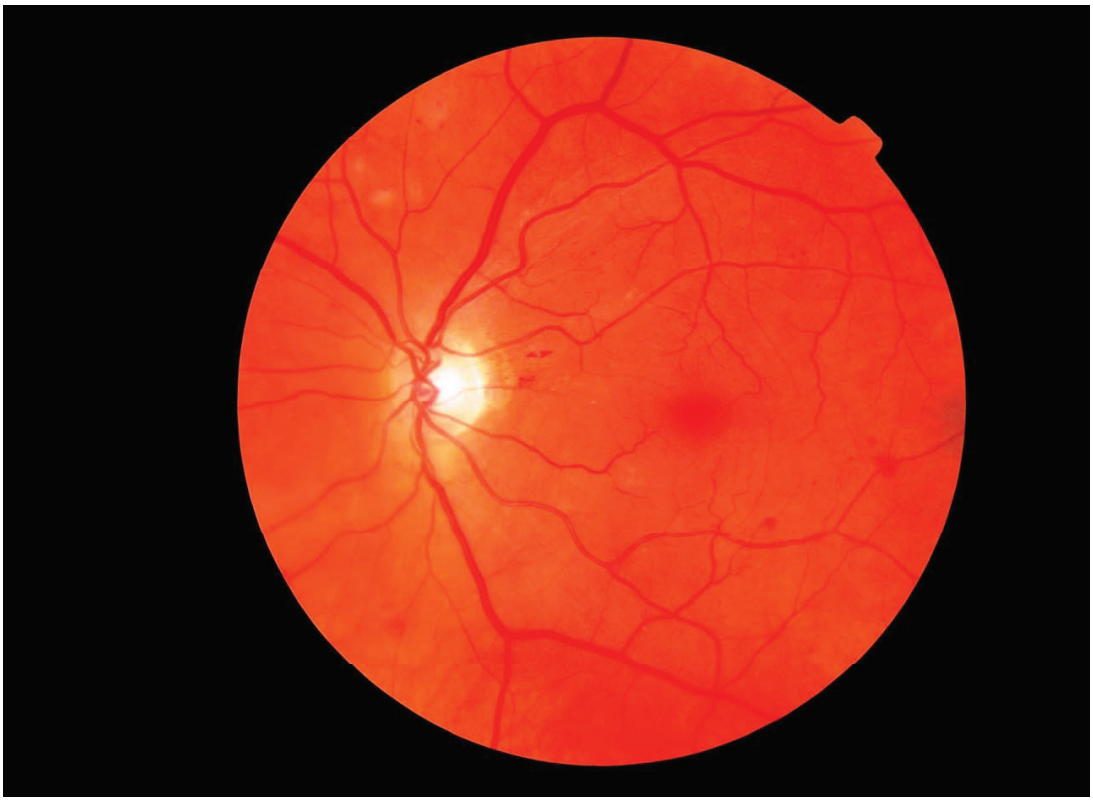
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 10, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

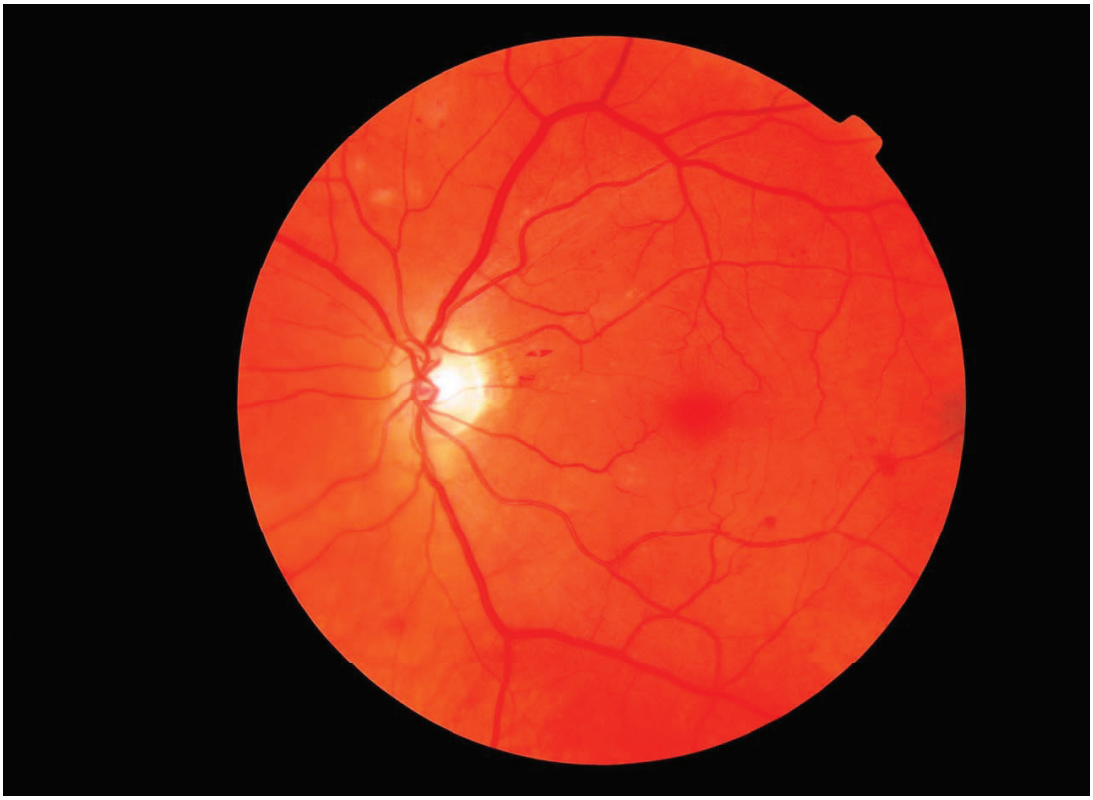


Bilde nr 10, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose

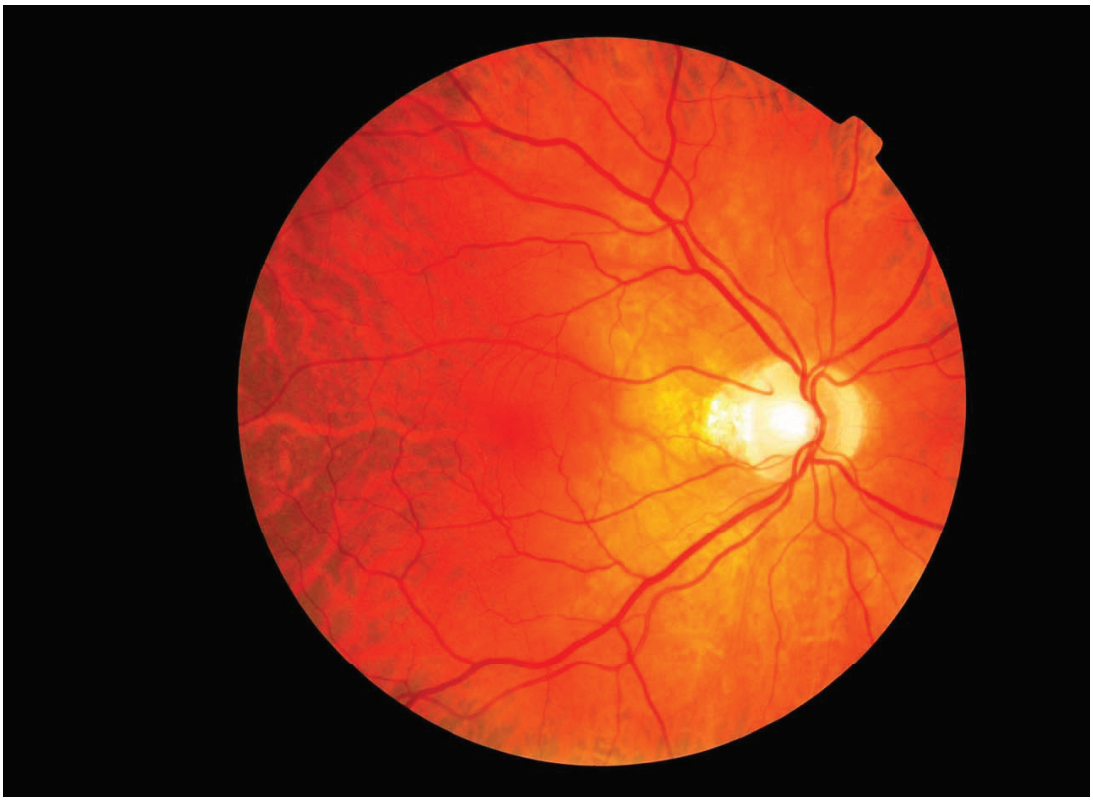


Bilde 10, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

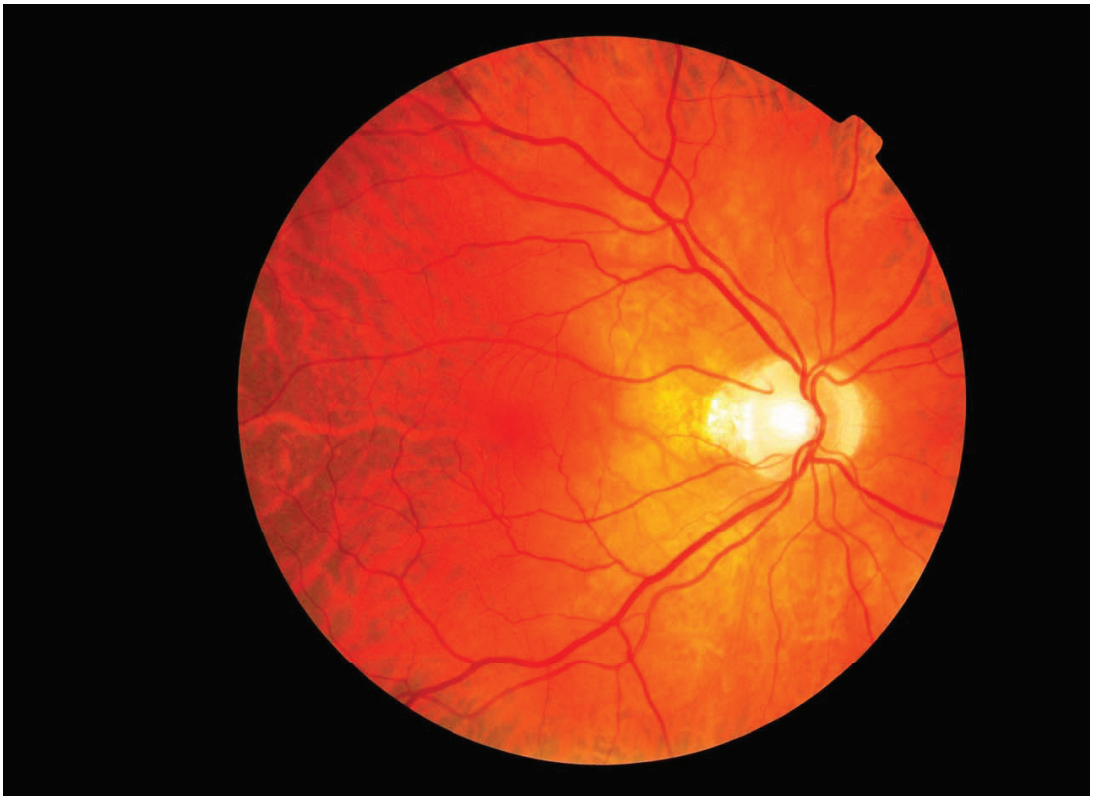
- 0 Ingen videre oppfølging / Rutineoppfølging
- 0 Rapport til fastlege
- 0 Henvising til fastlege
- 0 Henvising til øyelege



Bilde nr 11, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

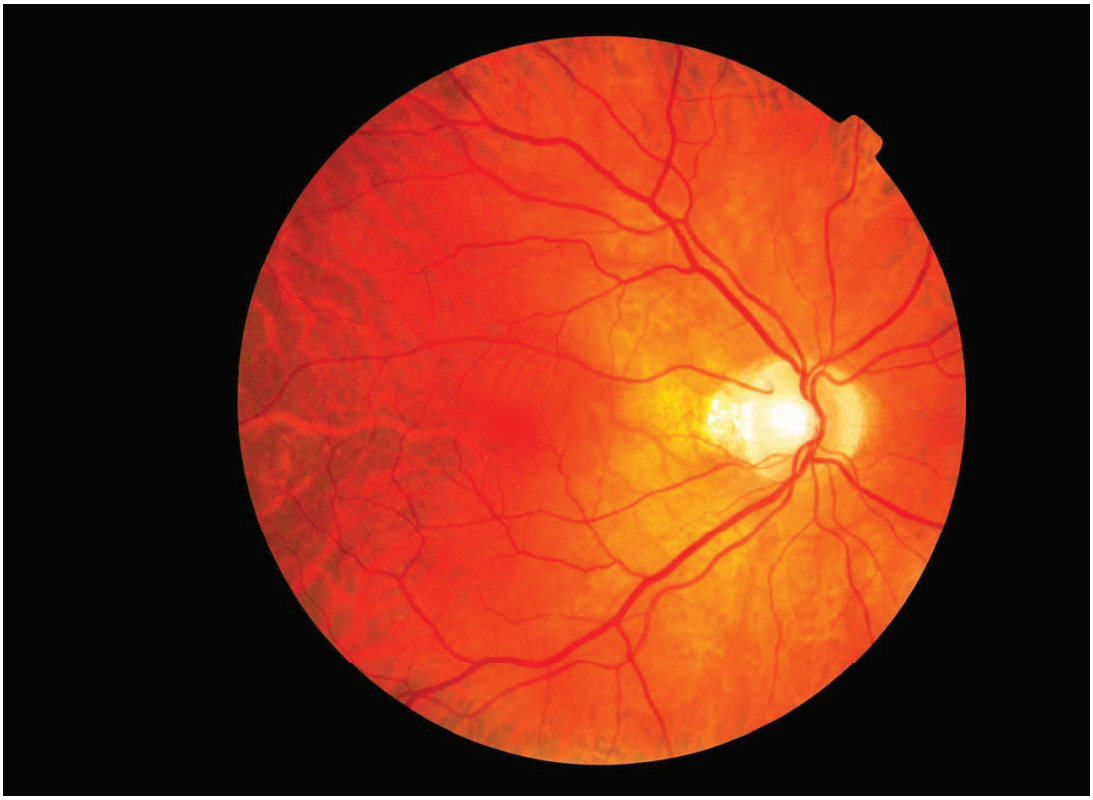


Bilde nr 11, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- ☐ Ingen retinopati
- ☐ Mikroaneurysmer
- ☐ Blødninger
- ☐ Harde eksudater
- ☐ Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- ☐ Venøs kaliberveksling
- ☐ IRMA
- ☐ IRMA (intraretinale mikrovaskulære abnormaliteter)
- ☐ Andre funn / annen tentativ diagnose

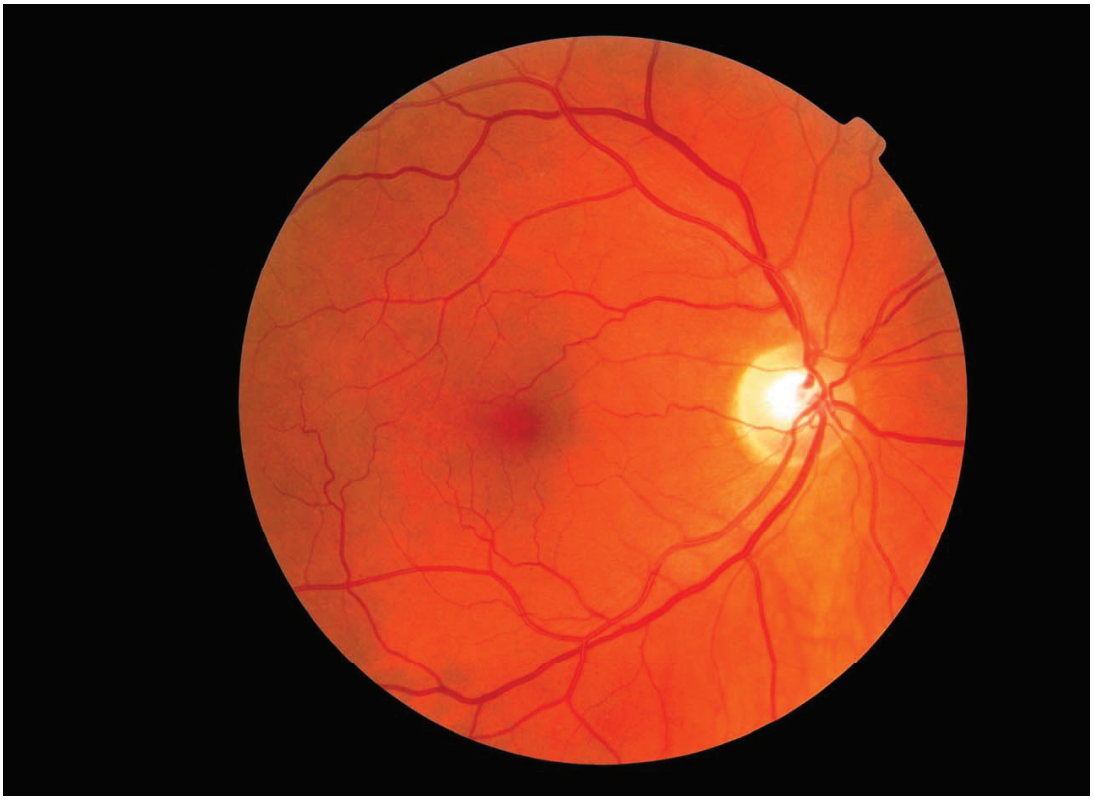


Bilde 11, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

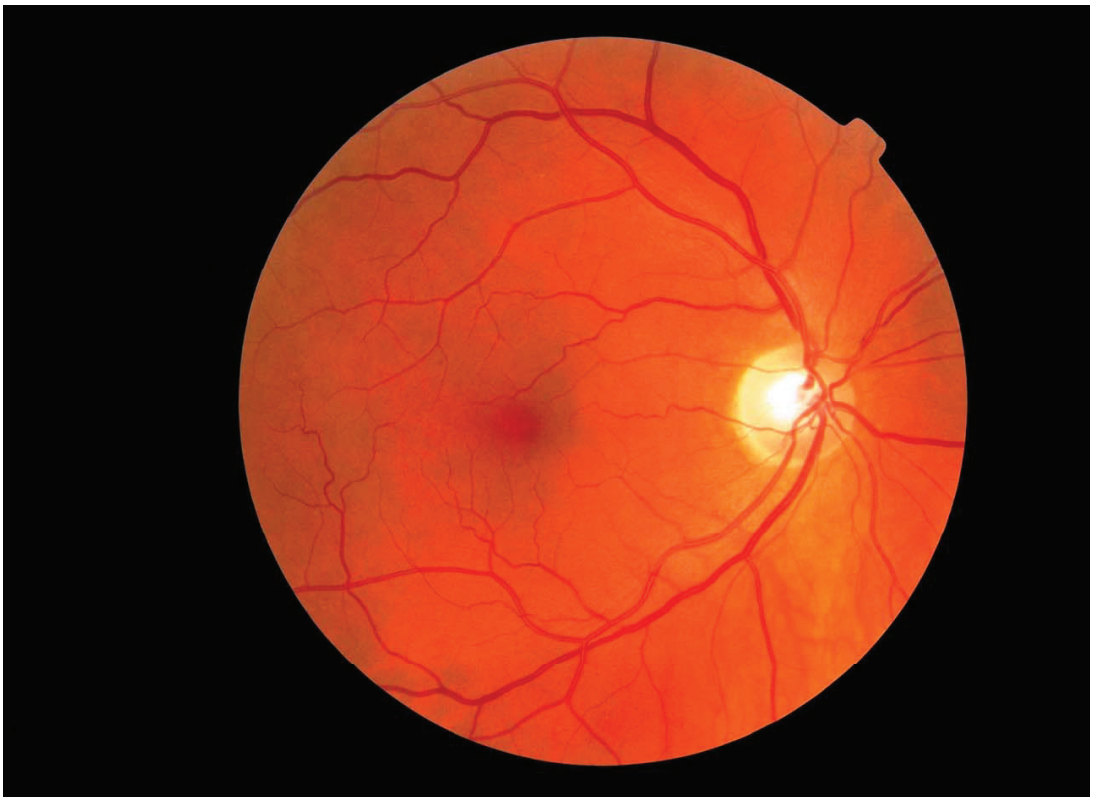
- 0 Ingen videre oppfølging / Rutineoppfølging
- 0 Rapport til fastlege
- 0 Henvising til fastlege
- 0 Henvising til øyelege



Bilde nr 12, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- ☐ Ja
- ☐ Nei

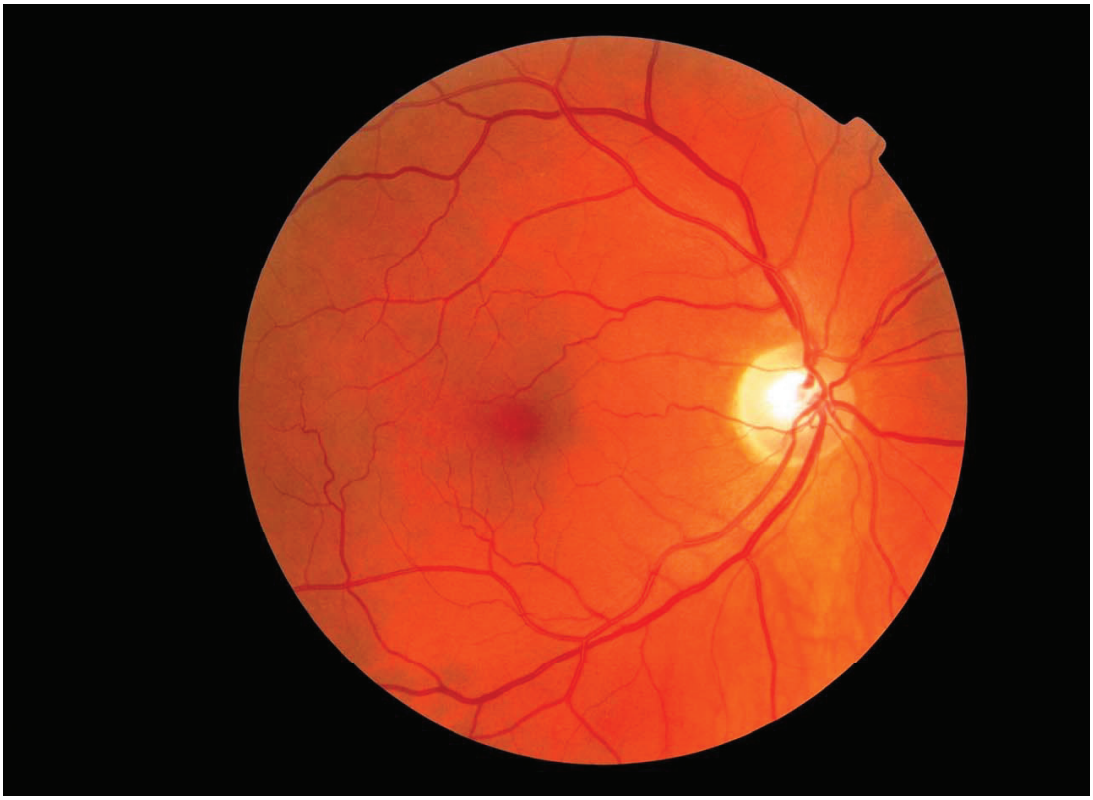


Bilde nr 12, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- ☐ Ingen retinopati
- ☐ Mikroaneurysmer
- ☐ Blødninger
- ☐ Harde eksudater
- ☐ Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- ☐ Venøs kaliberveksling
- ☐ IRMA (intraretinale mikrovaskulære abnormaliteter)
- ☐ Neovaskularisering
- ☐ Andre funn / annen tentativ diagnose

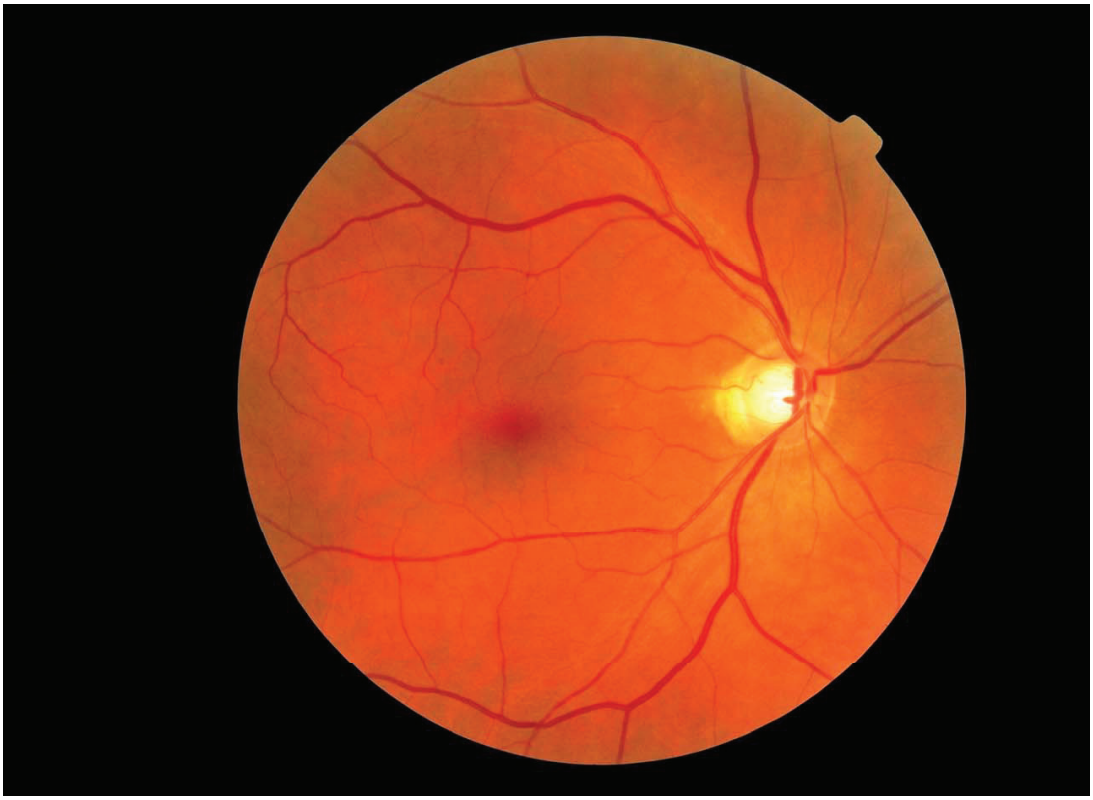


Bilde 12, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

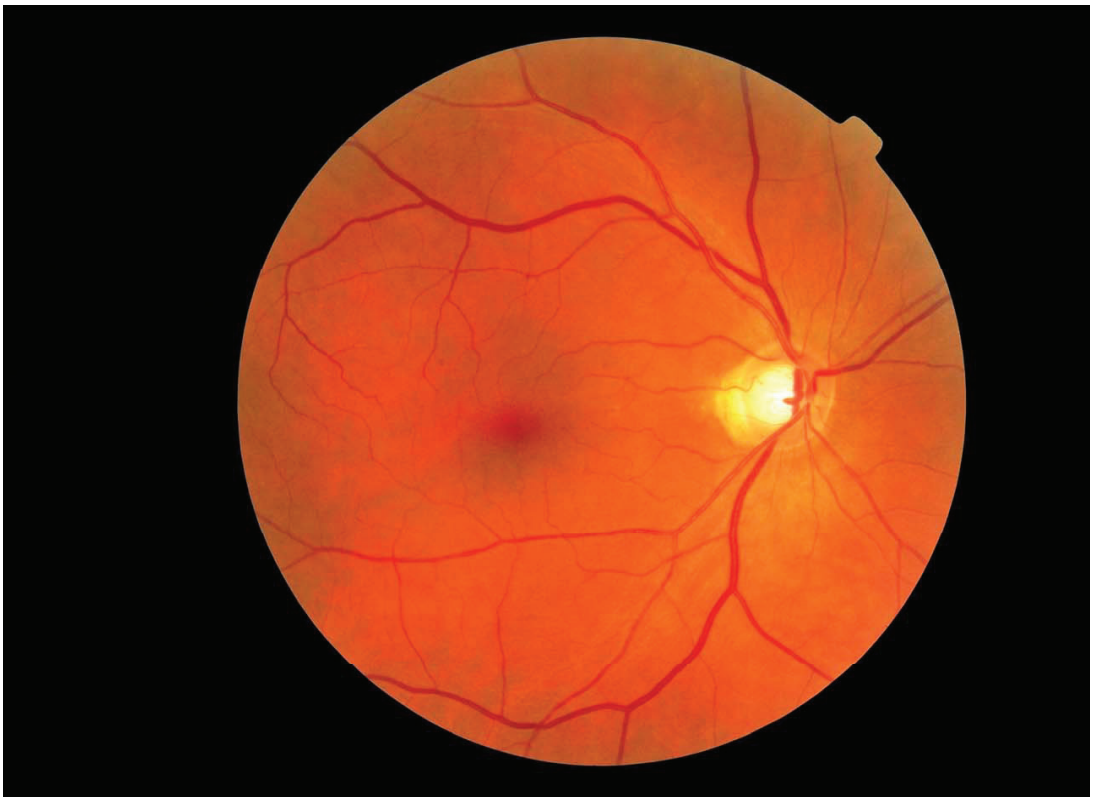
- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege



Bilde nr 13, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

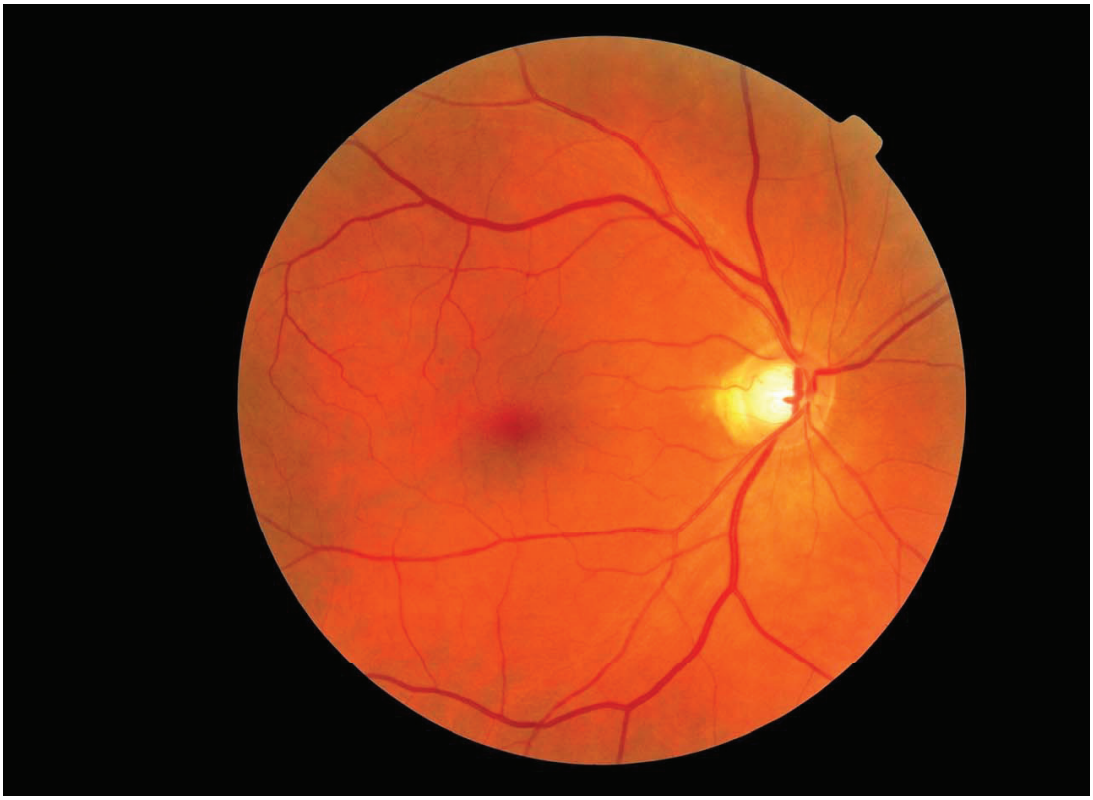


Bilde nr 13, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- ☐ Ingen retinopati
- ☐ Mikroaneurysmer
- ☐ Blødninger
- ☐ Harde eksudater
- ☐ Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- ☐ Venøs kaliberveksling
- ☐ IRMA (intraretinale mikrovaskulære abnormaliteter)
- ☐ Neovaskularisering
- ☐ Andre funn / annen tentativ diagnose

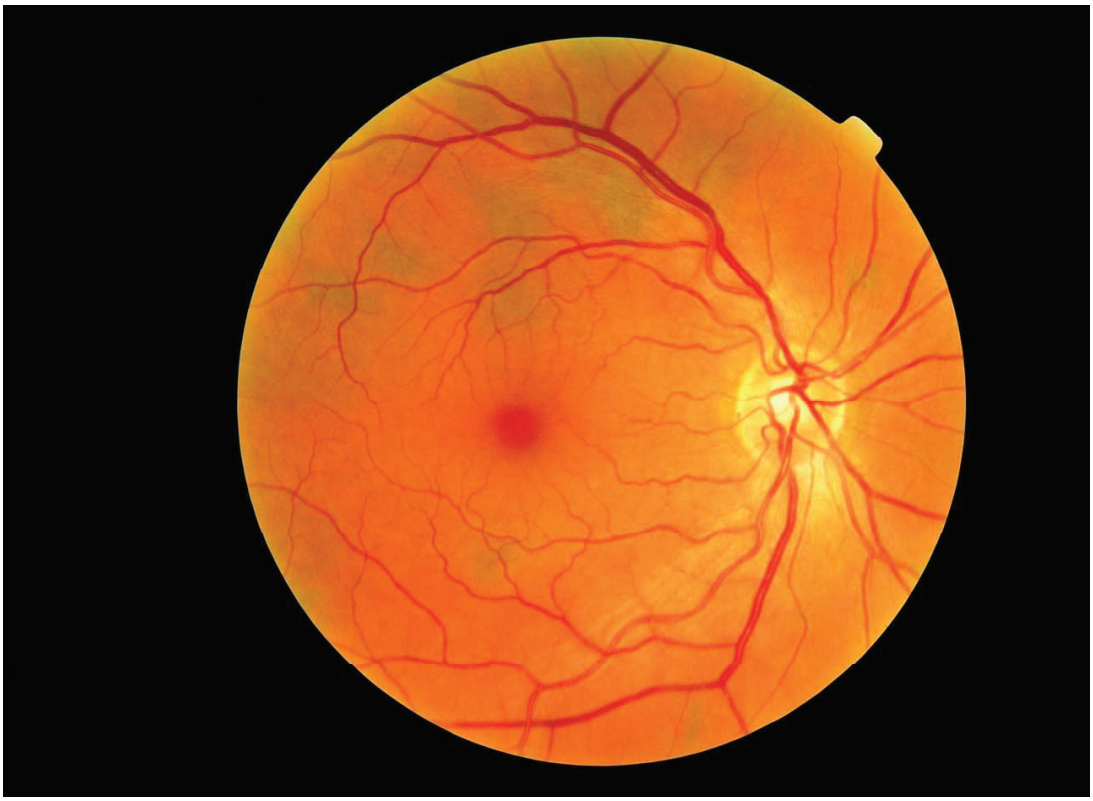


Bilde 13, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

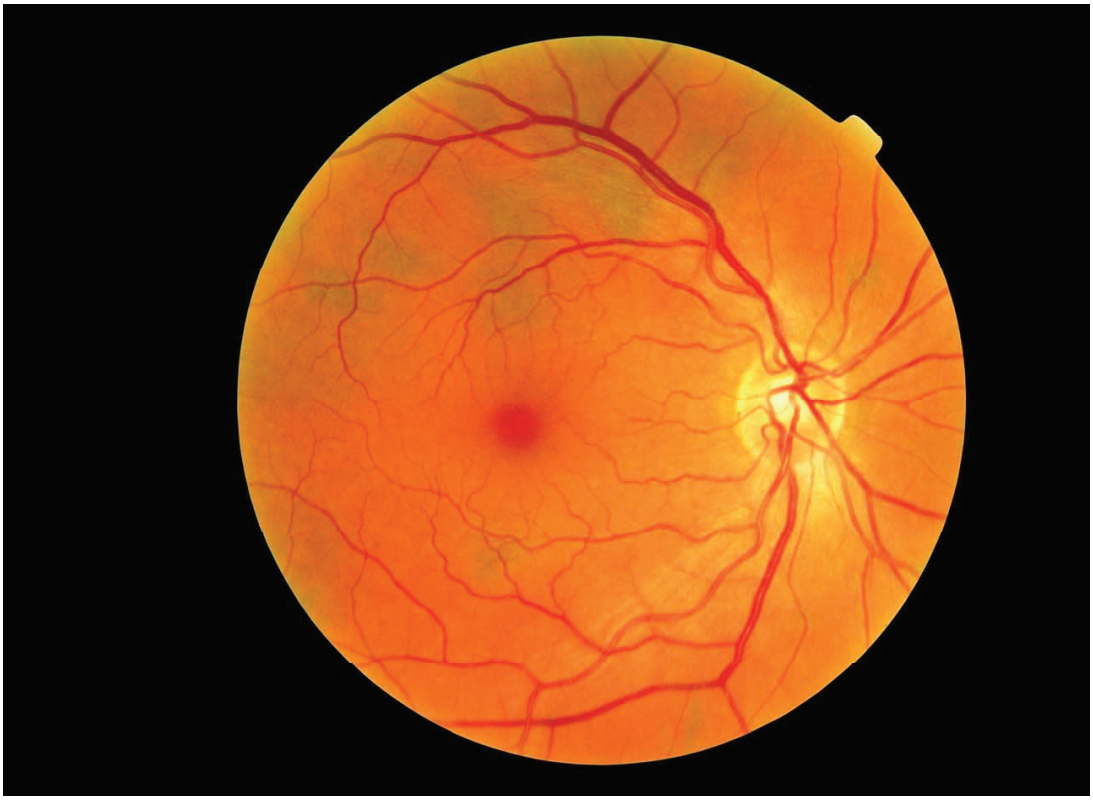
- 0 Ingen videre oppfølging / Rutineoppfølging
- 0 Rapport til fastlege
- 0 Henvising til fastlege
- 0 Henvising til øyelege



Bilde nr 14, spørsmål 1 av 3.

Etter din vurdering er dette et øye med diabetes retinopati?

- Ja
- Nei

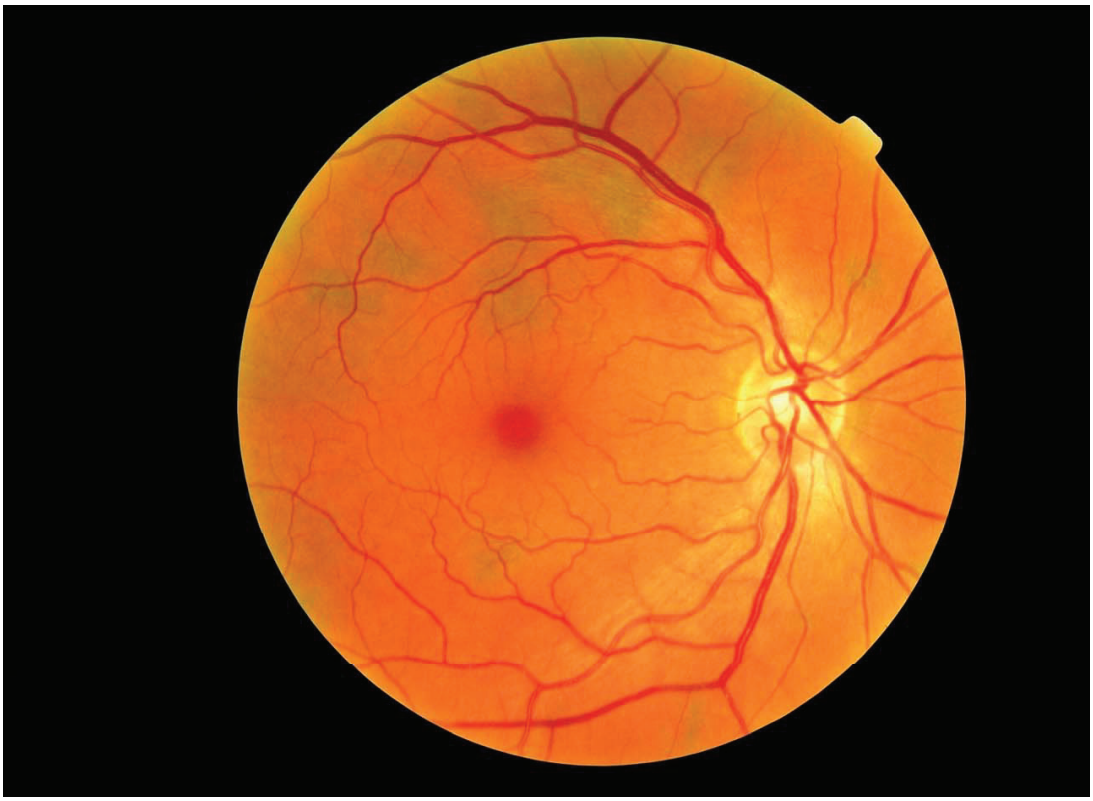


Bilde nr 14, spørsmål 2 av 3.

Hvilke funn på bildet la du til grunn for din vurdering?

(Du kan sette flere kryss)

- 0 Ingen retinopati
- 0 Mikroaneurysmer
- 0 Blødninger
- 0 Harde eksudater
- 0 Fibersjiktsinfarkt (bløte eksudater/cottonwool spots)
- 0 Venøs kaliberveksling
- 0 IRMA (intraretinale mikrovaskulære abnormaliteter)
- 0 Neovaskularisering
- 0 Andre funn / annen tentativ diagnose



Bilde 14, spørsmål 3 av 3.

Basert på retinopatifunn alene, hvordan ville du håndtert denne personen, dersom vedkommende ikke følges opp hos øyelege?

(Du kan sette flere kryss)

- ☐ Ingen videre oppfølging / Rutineoppfølging
- ☐ Rapport til fastlege
- ☐ Henvising til fastlege
- ☐ Henvising til øyelege

Hvilke instrumenter har du tilgjengelig for netthinneundersøkelse i din praksis?

(Du kan sette flere kryss)

- ☐ Direkte oftalmoskop
- ☐ Indirekte oftalmoskop (spaltelampe og Volk-linse)
- ☐ Funduskamera
- ☐ Optomap
- ☐ OCT
- ☐ Annet

Generelt, hvilken metode benytter du vanligvis for netthinneundersøkelse?

(Kun ett kryss er mulig)

- ☐ Udilatert direkte oftalmoskopi
- ☐ Dilatert direkte oftalmoskopi
- ☐ Udilatert indirekte oftalmoskopi (spaltelampe og Volk linse)
- ☐ Dilatert indirekte oftalmoskopi (spaltelampe og Volk linse)
- ☐ Fundusfotografering
- ☐ Annet

Dersom personen du undersøker har kjent diabetes, hvilken metode benytter du vanligvis for netthinneundersøkelse?

(Du kan sette flere kryss)

- ☐ Udilatert direkte oftalmoskopi
- ☐ Dilatert direkte oftalmoskopi
- ☐ Udilatert indirekte oftalmoskopi (spaltelampe og Volk linse)
- ☐ Dilatert indirekte oftalmoskopi (spaltelampe og Volk linse)
- ☐ Udilatert fundusfotografering
- ☐ Dilatert fundusfotografering
- ☐ Annet

Hvilke instrumenter har du tilgjengelig for netthinnefotografering?

(Du kan sette flere kryss)

- ☐ Ingen
- ☐ Funduskamera (film)
- ☐ Digitalt funduskamera
- ☐ Vidvinkel skanninglaser oftalmoskop (Optomap)
- ☐ Annet

Hvor mange år har du jobbet som optiker?

(Fyll inn antall hele år, kun siffer)

Skriv svaret ditt:

Har du rekvireringsrett for diagnostiske medikamenter?

- Ja
- Nei

Hva er din høyeste akademiske utdanning innen optikk / optometri?

- Yrkesskole / fagbrev
- 2-årig høyskole
- 3-årig høyskole
- BSc
- MSc
- PhD

Er du kvinner eller mann?

- Kvinne
- Mann

Du har besvart siste spørsmål.
Du kan fortsatt gå tilbake og endre dine svar.
Klikk neste dersom du er ferdig og ønsker å sende inn svarene nå.

Appendix 8

Hvorfor du er invitert

Du er blitt spurt om å delta i studien: " GLUP 2 - SYN. Diabetes, syn og øyehelse" som oppfølging og utvidelse av Glukosebelastningsprosjektet, GLUP, som ble gjennomført ved HUNT forskningssenter i fjor. 200 personer er forespurt om å delta i undersøkelsen.

Begrunnelse for forskningsprosjektet

Diabetes er en sykdom med økende forekomst. Trolig har 90-120 000 mennesker i Norge diagnostisert diabetes, mens nesten like mange kan ha uoppdaget diabetes. En alvorlig senkomplikasjon ved diabetes er diabetes retinopati, forandringer i øyets netthinne. I tillegg kan diabetes forårsake endringer i brytningsfeil og samsyn.

Kunnskap om syn og øyehelse hos pasienter med diabetes er viktig for å kunne planlegge, utvikle og kvalitetsikre oppfølgingen av syn og øyehelse hos pasienter med diabetes.

Formålet med prosjektet

Formålet med undersøkelsen er å gi en beskrivelse av syn og øyehelse hos pasienter med kjent diabetes og nedsatt glukose toleranse. Undersøkelsen vil benyttes som forundersøkelse for studien "Diabetes, syn og øyehelse" som planlegges for HUNT 3.

Metoder

Undersøkelsen vil ta ca. 1 time og inkluderer et spørreskjema, synsundersøkelse og fotografering av øyebunnen.

Praktiske ulemper i forbindlese med undersøkelsen

Dersom det må benyttes øyedråper for å oppnå god nok kvalitet på bildene av øyebunnen, kan du oppleve kortvarig forbigående lysfølsomhet og manglende evne til å se på nært hold. Dette skyldes at pupillen blir midlertidig utvidet.

Fordeler ved deltagelse

Du vil få skrevet ut brilleseddel.

Undersøkelsen erstatter ikke regelmessig undersøkelse av øynene som foretas av øyelege/lege.

Frivillighet

Deltagelse i studien er frivillig. Du kan på hvilket som helst tidspunkt trekke deg fra studien uten å oppgi grunn.

Konfidensialitet

All informasjon vil bli behandlet konfidensielt, og alle prosjektmedarbeidere har taushetsplikt.

Prosjektet er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS og tilråd i den regionale komité for medisinsk forskningsetikk.

Dersom du velger å avslutte deltagelsen, vil dataene som er registrert bli slettet.

Du vil ikke kunne identifiseres i publikasjoner fra studiet.

Studien finansieres av Norges Optikerforbund, høgskolen i Buskerud og HUNT forskningssenter.

Studiet er knyttet til HUNT forskningssenter og Høgskolen i Buskerud, Institutt for optometri og synsvitenskap.
Prosjektleder er stipendiat Vibeke Sundling.
Prosjektleder har ingen økonomiske interesser i prosjektet.

Har du spørsmål om studien ta kontakt med:

Stipendiat Vibeke Sundling

Høgskolen i Buskerud
Institutt for optometri og synsvitenskap
tlf: 32 86 97 59
email: vibeke.sundling@hibu.no

NTNU
Det skapende universitet

HØGSKOLEN
i Buskerud

SAMTYKKEERKLÆRING

VED INNSAMLING OG BRUK AV
PERSONOPPLYSNINGER TIL FORSKNINGSFORMÅL

PROSJEKTITTEL:
GLUP 2 - SYN. Diabetes, syn og øyehelse.

PROSJEKTLEDER:
Stipendiat Vibeke Sundling

FORMÅL:
Kartlegge syn- og øyeforandringer hos personer med diabetes og nedsatt glukose toleranse.

Jeg samtykker med dette til å delta i studien:
"GLUP 2 - SYN. Diabetes, syn og øyehelse."

Jeg er inneforstått med at deltagelse er frivillig, og at jeg kan trekke meg fra studien når som helst og uten å oppgi grunn.

Navn: _____

Sted: _____ Dato: _____

_____
Signatur

TAUSHETSERKLÆRING

PROSJEKTITTEL:
GLUP 2 - SYN. Diabetes, syn og øyehelse.

PROSJEKTLEDER:
Stipendiat Vibeke Sundling

FORMÅL:
Kartlegge syn- og øyeforandringer hos personer med diabetes og nedsatt glukose toleranse.

Prosjektet er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS og tilråd av den regionale komité for medisinsk forskningsetikk.

Jeg erklærer med dette at ingen personopplysninger som kommer oss i hende i forbindelse med studien vil være tilgjengelig for andre.

I forbindelse med utgivelse av en publikasjon eller lignende vil kun anonymiserte opplysninger bli gitt ut .

Sted: _____ Dato: _____

_____
Vibeke Sundling
prosjektleder

FORSKNINGSPROSJEKT OM SYN OG ØYEHELSE HOS PERSONER MED DIABETES ELLER NEDSATT GLUKOSETOLERANSE

VIL DU DELTA?

NTNU
Det skapende universitet

HØGSKOLEN
i Buskerud

Appendix 9

Variable list 1 Questionnaire - Optometric practice – Cross-section survey

No.	Variable	Definition	Type	Definition
1	**Optometrist demographic**			
1.1	Gender		Nominal	1 = male 2 = female
1.2	Age	Age of optometrist at the time of survey	Interval	Years
1.3	Academic background	Highest academic degree in optometry	Ordinal	1 = technical college 2 = 2 year university college 3 = 3 year university college 4 = BSc 5 = MSc 6 = PhD
1.4	Specialist competency	Specialty / accreditation / course	Nominal	1 = yes 2 = no
1.4.1	Diagnostic drugs	Speciality		
1.4.2	Contact lenses	Speciality		
1.4.3	Low vision	Accreditation		
1.4.4	Occupational optometry	Accreditation		
1.4.5	Anterior segment	Course		
1.4.6	Behavioural optometry	Course		
1.5	Work experience	Number of years in optometric practice	Interval	Years
1.6	Working hours	Number of working hours per week	Interval	Hours
1.8	Area	Practice location	Nominal	1 = city 2 = village 3 = rural
1.9	Practice	Type of practice	Nominal	1 = independent 2 = regional group 3 = national group
1.10	Geography	Health region	Nominal	1 = East 2 = South 3 = West 4 = Middle 5 = North
2	**Patient population**			
2.1	Patient volume	Number of eye examinations per week	Interval	Number
a.	Excluding contact lenses			
b.	Including contact lenses			
2.2	Diabetic patients	Estimated of patients with known diabetes	Interval	Percentage
3	**Eye examination**			
3.1	Routine examination	Tests included in the examination	Nominal	1 = yes 2 = no
3.1.1	Patient history			
3.1.2	Cover test			
3.1.3	Donders / confrontation test			
3.1.4	Motility			
3.1.5	Refraction			
3.1.6	Slit lamp examination			
3.1.7	Ophthalmoscopy			
3.1.7	Tonometry			
a.	All patients			
b.	All patients > __ years of age			
3.1.8	Visual field			
a.	All patients			
b.	All patients > __ years of age			
c.	If suspicion of field defect			

Variable list 1 Questionnaire - Optometric practice – Cross-section survey

No.	Variable	Definition	Type	Definition
3.2	Patient history	Questions directly related to diabetes		
3.2.1	General health	General health status	Nominal	1 = yes
3.2.2	Diabetes	Presence of diabetes		2 = no
3.2.3	Routine	Specific routine for patients with diabetes		
3.2.4	Type of diabetes	Frequency of question; when the patient has diabetes	Ordinal	1 = 0%
3.2.5	Duration			2 = < 25%
3.2.6	Blood glucose level			3 = 25-49%
3.2.7	Blood pressure			4 = 50%
3.2.8	Treatment			5 = 51-75%
3.2.9	Care of ocular health			6 = > 75%
3.2.10	Treatment of DR			7 = 100%
3.2.11	Variable VA			
3.2.12	Diplopia			
3.2.13	Transient ischemic attacks			
3.3	Vision	Visual problems related to diabetes	Ordinal	1 = 0%
3.3.1	Stability of refraction	Frequency of examination in patients with diabetes		2 = < 25%
3.3.2	Cover test and motility			3 = 25-49%
3.3.3	Colour vision			4 = 50%
3.3.5	Tonometry			5 = 51-75%
3.3.6	Visual field			6 = > 75%
3.3.7	Slit lamp examination Anterior segment			7 = 100%
3.3.8	Fundus examination			
3.3.9	Fundus photography			
3.3.10	Indication for tonometry	Indication for performing the test	Nominal	Open answer
3.3.11	Indication for visual field			
3.4	Fundus examination	Method used to examine fundus	Ordinal	1 = 0%
3.4.1	Dilated fundus examination	Extent of use		2 = < 25%
3.4.2	Direct ophthalmoscopy			3 = 25-49%
3.4.3	Slit lamp indirect ophthalmoscopy			4 = 50%
3.4.4	Monocular indirect ophthalmoscopy			5 = 51-75%
3.4.5	Binocular indirect ophthalmoscopy			6 = > 75%
3.4.6	Fundus photography			7 = 100%
3.5	Skills	Optometrist evaluation of own skills	Ordinal	1 = poor
3.5.1	Direct ophthalmoscopy	Grading of skill		2 = fairly poor
3.5.2	Slit lamp indirect ophthalmoscopy			3 = fairly confident
3.5.3	Fundus photography			4 = confident
3.5.4	Assessment of fundus			
4	**Report and referral**	**Report and referral to other health care providers**		
4.1	Report to general practitioner	When report about patients with diabetes is sent to GP	Ordinal	1 = never
				2 = if ocular changes present
				3 = depend on ocular change
				4 = always
				5 = if asked by GP or patient
4.2	Referral to GP/Ophthalmologist	When signs of retinopathy leads to referral	Nominal	1 = always
				2 = patients seen by ophthalmologist, depend on degree
				3 = depend on degree
4.2.2	Diabetes retinopathy	Number of patients with unknown diabetes referred with possible diabetic retinopathy during the last year	Interval	Number
4.2.3	Diabetes	Number of patients with unknown diabetes referred with suspect diabetes (refractive shift, other ocular signs) during the last year		

Variable list 1 Questionnaire - Optometric practice – Cross-section survey

No.	Variable	Definition	Type	Definition
5	**Collaboration**	**Collaboration with other health care providers**		
5.1	General Practitioners	Formal collaboration with GP	Nominal	1 = yes
				2 = no
5.1.1	No collaboration			
5.1.2	Refer / confer by phone			
5.1.3	Send reports			
5.1.4	Send referrals			
5.1.5	Receive patient summary			
5.1.6	Receive referral			
5.1.7	Joint practice			
5.2	Ophthalmologists	Formal collaboration with ophthalmologist	Nominal	1 = yes
5.1.1	No collaboration			2 = no
5.1.2	Refer / confer by phone			
5.1.3	Send reports			
5.1.4	Send referrals			
5.1.5	Receive patient summary			
5.1.6	Receive referral			
5.1.7	Joint practice			

Variable list 2 Practice registration - Optometric practice – Cross-section survey

No.	Variable	Definition	Type	Definition
1	**Optometrist demographic**			
1.1	Gender		Nominal	1 = male 2 = female
1.2	Age	Age of optometrist at the time of survey	Interval	Years
1.3	Academic background	Highest academic degree in optometry	Ordinal	1 = technical college 2 = 2 year university college 3 = 3 year university college 4 = BSc 5 = MSc 6 = PhD
1.4	Specialist competency	Specialty / accreditation / course	Nominal	1 = yes 2 = no
1.4.1	Diagnostic drugs	Speciality		
1.4.2	Contact lenses	Speciality		
1.4.3	Rehabilitation of visual impairment	Accreditation		
1.4.4	Occupational optometry	Accreditation		
1.4.5	Anterior segment	Course		
1.4.6	Behavioural optometry	Course		
1.5	Work experience	Number of years in optometric practice	Interval	Years
1.6	Working hours	Number of working hours per week	Interval	Hours
1.8	Area	Practice location	Nominal	1 = city 2 = village 3 = rural
1.9	Practice	Type of practice	Nominal	1 = independent 2 = regional group 3 = national group
1.10	Geography	Health region	Nominal	1 = East 2 = South 3 = West 4 = Middle 5 = North
2	**Patient demographic**			
2.1	Age	Age of patient at the time of study	Interval	Years
2.2	Sex	Patient sex	Nominal	1 = male 2 = female
3	**Ocular examination**	**Applicable to all patients**		
3.1	Patient history	Questions with positive answer	Nominal	1 = yes 2 = no
3.1.1	Glaucoma			
3.1.2	AMD			
3.1.3	Cataract			
3.1.4	Diabetes Mellitus			
3.1.5	Hypertension			
3.1.6	Heart disease			
3.1.7	Diabetes Mellitus in the family			
3.2	Vision and ocular health	Applicable to all patients		
3.2.1	Best corrected visual acuity	Best corrected visual acuity Monocular od and os	Interval	Snellen Decimal
3.2.2	Intra ocular pressure	Intra ocular pressure od and os	Interval	mmHg
3.2.3	Cataract	Presence of cataract od and os	Nominal	1 = yes
3.2.4	Ophthalmoscopy	Examination performed		2 = no
3.2.5	Dilated fundus examination	Examination performed		
3.2.6	Diabetic retinopathy	Retinopathy present		
3.2.7	Type of retinopathy	Type of retinopathy present	Nominal	String

Variable list 2 Practice registration - Optometric practice – Cross-section survey

No.	Variable	Definition	Type	Definition
4	**Communication**			
4.1	None	No referral or routine follow up	Nominal	1 = yes
4.2	Patient	Patient contacts GP		2 = no
4.3	Report	Report sent		
4.4	Referral	Referral sent		
5	**Diabetes status**	**Only applicable to patients with diabetes**		
5.1	Type of diabetes	Questions asked and answer specified	Nominal	1 = Type 1 2 = Type 2
5.2	Duration		Interval	Years
5.3	Blood glucose level		Interval	HbA1c
5.4	Blood pressure		Nominal or Interval	1 = too low 2 = normal 3 = too low
5.5	Treatment		Nominal	1 = diet 2 = oral medication 3 = insulin
5.6	Presence known retinopathy		Nominal	1 = yes
5.7	Treatment of retinopathy			2 = no
6	**Vision**	**Only applicable to patients with diabetes or patients referred**		
6.1	Variable VA		Nominal	1 = yes
6.2	Visual impairment			2 = no
6.3	Diplopia			
6.4	Refraction	Stability / Refractive shifts	Nominal	1 = previous Rx unknown 2 = stable 3 = myopic shift (>1D) 4 = hyperopic shift (>1D)
7	**Referral**	**Only applicable to patients referred**		
7.1	Health care provider	Recipient of referral	Nominal	1 = GP 2 = ophthalmologist 3 = emergency clinic 4 = other
7.2	Reason	Reason for referral Applicable to referred patients	Nominal	1 = reduced VA 2 = intra ocular pressure 3 = binocular vision 4 = anterior segment 5 = diabetic retinopathy 6 = hypertensive retinopathy 5 = unspecified retinopathy 6 = AMD 7 = headache

Variable list 3 Questionnaire member of the Norwegian Diabetes Association – Cross-section survey

No.	Variable	Definition	Type	Definition
1.	**Patient demographic**			
1.1	Gender		Nominal	1 = male 2 = female
1.2	Age	Year of birth	Interval	Year
1.3	Diabetes	Type of diabetes	Nominal	1 = type 1 2 = type 2 3 = other 4 = unsure
2.	**Risk factors of diabetic retinopathy**			
2.1	Diabetes	Duration of diabetes	Interval	Years
2.2	Treatment	Type of treatment	Nominal	1 = diet 2 = exercise 3 = weight reduction 4 = oral medication 5 = insulin
2.3	Blood glucose			
2.3.1	HbA1c	HbA1c at previous diabetes examination	Interval	Given in %
2.3.2	Control	Stability of blood glucose level previous year	Nominal	1 = yes 2 = no 3 = unsure
2.4	Blood pressure	Blood pressure at previous diabetes examination, systolic and diastolic	Interval	Given in mmHg or unsure
2.5	Medication			
2.5.1	Blood pressure	Blood pressure lowering medication	Nominal	1 = yes
2.5.2	Cholesterol	Cholesterol lowering medication		2 = no 3 = unsure
2.6	Smoking			
2.6.1	Present	Present smoking	Nominal	1 = yes 2 = no
2.6.2	Amount	Number of cigarette a day	Interval	Number
2.6.3	Previous	Previous smoking	Nominal	1 = yes 2 = no
3.	**Vision and ocular health care**			
3.1	Vision examination			
3.1.1	Examination	Who perform regular examination of vision	Nominal	1 = no regular exam 2 = optometrist 3 = ophthalmologist 4 = other MD 5 = other
3.1.2	Examination interval	Frequency of eye examination	Interval	Years / Months
3.1.3	Patient satisfaction	Patient satisfaction with vision care	Ordinal	1 = very unsatisfied 5 = very satisfied

Variable list 3 Questionnaire member of the Norwegian Diabetes Association – Cross-section survey

No.	Variable	Definition	Type	Definition
3.2	Fundus examination			
3.2.1	First examination	Time of first fundus examination	Ordinal	1 = never examined 2 = within 1 year 3 = within 5 years 4 = unsure 5 = other
3.2.2	Regular fundus examination	Regular examination of the retina with regard to diabetic retinopathy	Nominal	1 = yes 2 = no
3.2.3	Examination interval	Frequency of retina examination	Interval	Months / years
3.2.4	Examination method	How the fundus is examined	Nominal	1 = photography 2 = ophthalmologist 3 = GP 4 = optometrist 5 = unsure
3.2.5	General practitioner	Fundus examination performed by GP.	Nominal	1 = yes 2 = no 3 = unsure
3.2.6	Patient satisfaction	Patient satisfaction with ocular health care	Ordinal	1 = very unsatisfied 5 = very satisfied
3.3	Patient behaviour and knowledge			
3.3.1	Vision care provider	Patient choice of vision care provider in case of visual problems	Nominal	1 = MD 2 = optometrist 3 = ophthalmologist 4 = hospital eye dep. 5 = unsure
3.3.2	Information	Received information about importance of regular eye exams due to diabetes	Nominal	1 = yes 2 = no 3 = unsure
3.3.3	Source of information	Source of information about importance of regular eye exams.	Nominal	1 = GP 2 = ophthalmologist 3 = other MD 4 = optometrist 5 = hospital 6 = course in diabetes 7 = brochures/Diabetes 8 = newspaper/ magazine/radio/TV 9 = other with diabetes 10 = other
4	**Vision**			
4.1	Optical correction	Type of optical correction used	Nominal	1 = distance 2 = reading / do 3 = bifocal / multifocal 4 = contact lenses 5 = loupe / LVA 6 = none
4.2	Vision			
4.2.1	Visual problems due to diabetes	Visual problems related by medical practitioner to diabetes	Nominal	1 = yes 2 = no 3 = unsure
4.2.2	Visual problems	Visual problems experienced by the patient	Nominal	1 = blurred vision 2 = variable vision 3 = visual field defects 4 = diplopia 5 = metamorphopsia 6 = other
4.2.3		Visual problems relived by spectacles/contact lenses	Nominal	1 = yes 2 = no

Variable list 3 Questionnaire member of the Norwegian Diabetes Association – Cross-section survey

No.	Variable	Definition	Type	Definition
4.3	Ocular health			
4.3.1	Treatment of diabetic retinopathy	Previous treatment of diabetic retinopathy	Nominal	1 = yes 2 = no 3 = unsure
4.3.2	Ocular disease	Known ocular disease	Nominal	1 = diabetic retinopathy 2 = other retinopathy 3 = AMD 4 = glaucoma 5 = cataract 6 = other

Variable list 4 Clinical examination of a sample of the HUNT population – Cross-section survey

No.	Variable	Definition	Type	Definition
1.	**Patient demographic**			
1.1	Gender		Nominal	1 = male 2 = female
1.2	Age	Year of birth	Interval	Year
2.	**Patient history**	**Vision, ocular and general health**		
2.1	Visual symptoms	Experience visual symptoms	Nominal	1 = yes 2 = no
2.1.1	Blurred vision			
2.1.2	Variable vision			
2.1.3	Visual field defects	Positive and negative visual field defects		
2.1.4	Diplopia			
2.1.5	Metamorphopsia			
2.1.6	Photophobia			
2.1.7	Optically corrected	Symptoms alleviated with optical correction		
2.2	Optical correction	Use of optical correction	Nominal	1 = yes 2 = no
2.2.1	Distance correction			
2.2.2	Near correction			
2.2.3	Multifocal correction			
2.2.4	Contact lenses			
2.2.5	Low vision aids			
2.3	Vision and eye examination			
2.3.1	Regular vision examination	Examination of vision (visual acuity)	Nominal	1 = yes 2 = no
2.3.2	Health care provider	Profession undertaking the vision examination	Nominal	1 = optometrist 2 = ophthalmologist
2.3.3	Follow-up vision	Examination interval	Interval	Months
2.3.4	Regular eye examination	Examination of ocular health	Nominal	1 = yes 2 = no
2.3.5	Health care provider	Profession undertaking the eye examination	Nominal	1 = optometrist 2 = ophthalmologist
2.3.6	Follow-up ocular health	Examination interval	Interval	Months
2.4	Ocular health	History of ocular disease	Nominal	1 = yes 2 = no
2.4.1	Diabetic retinopathy			
2.4.2	Other retinopathy			
2.4.3	AMD			
2.4.4	Glaucoma			
2.4.5	Cataract			
2.4.6	Other ocular disease			
2.5	General health	History of systemic disease		
2.5.1	Diabetes		Nominal	1 = yes 2 = no
2.5.2	Family history of diabetes			
2.5.3	Cardio-vascular disease			
2.5.4	Blood pressure	Knowledge of blood pressure	Ordinal	1 = low 2 = normal 3 = high 4 = unsure
2.5.4	Blood pressure level	Value at last physical examination	Interval	mmHg
3	**Ocular health**	**Examination of ocular health**		
3.1	Tonometry	Intra ocular pressure (IOP)	Interval	mmHg
3.2	Lens assessment	Cataract present	Nominal	1 = yes 2 = no
3.3	Fundus photography	Examination of retinal photographs		
3.3.1	Retinal assessment	Normal retina	Nominal	1 = yes 2 = no 3 = ungradeable photos
3.3.2	Type of retinopathy		Nominal	0 = none 1 = diabetic 2 = hypertensive 3 = other vascular 4 = AMD 5 = other retinopathy

Variable list 4 Clinical examination of a sample of the HUNT population – Cross-section survey

No.	Variable	Definition	Type	Definition
3.3.3	Diabetic retinopathy	Grading of diabetic retinopathy (DR) Non-proliferative: NPDR Proliferative: PDR	Ordinal	0 = no 1 = mild NPDR 2 = moderate NPDR 3 = severe NPDR 4 = proliferative 5 = laser-treated
3.3.4	Optic nerve assessment	Normal optic nerve head	Nominal	1 = yes 2 = no
4.	**Visual function**			
4.1	Refraction and acuity	Optical correction and visual acuity		
4.1.1	Habitual optical correction	Current optical correction	Interval	DS/DC
4.1.1	Habitual VA	Visual acuity with current correction	Interval	logMAR and Snellen
4.1.1	Optimal optical correction	Best optical correction	Interval	DS/DC
4.1.1	Best corrected VA	Visual with best optical correction	Interval	logMAR and Snellen
4.2	Visual field	Assessment of central visual field		
4.2.1	Amsler field		Nominal	1 = normal 2 = visual field defect
4.3	Contrast sensitivity	Assessment of contrast sensitivity		
4.3.1	CSF	Contrast sensitivity function curve	Nominal	1 = normal 2 = abnormal
4.3.2	Contrast sensitivity 1.5	Contrast level at 1.5 c/deg	Ordinal	1 = 3 2 = 7 3 = 12 4 = 20 5 = 35 6 = 70 7 = 120 8 = 170
4.3.2	Contrast sensitivity 3	Contrast level at 3 c/deg	Ordinal	1 = 4 2 = 9 3 = 15 4 = 24 5 = 44 6 = 85 7 = 170 8 = 220
4.3.2	Contrast sensitivity 6	Contrast level at 6 c/deg	Ordinal	1 = 5 2 = 11 3 = 21 4 = 45 5 = 70 6 = 125 7 = 185 8 = 260
4.3.2	Contrast sensitivity 12	Contrast level at 12 c/deg	Ordinal	1 = 5 2 = 8 3 = 15 4 = 32 5 = 55 6 = 88 7 = 125 8 = 260
4.3.2	Contrast sensitivity 18	Contrast level at 18 c/deg	Ordinal	1 = 4 2 = 7 3 = 10 4 = 15 5 = 26 6 = 40 7 = 65 8 = 90

Variable list 5 Visual identification of Ophthalmological Conditions (VIMOC) Examination

No.	Variable	Definition	Type	Definition
1	**Diabetic Retinopathy**			
1.1	Diabetic retinopathy	Presences of clinical findings of diabetic retinopathy	Nominal	1 = yes 2 = no
1.2	Clinical findings	Specification of clinical findings	Nominal	1 = no retinopathy 2 = microaneurysms 3 = hard exudates 4 = cotton wool spots 5 = venous beading 6 = intraretinal microvascular abnormalities (IRMA) 7 = neovascularisation 8 = other findings
2	**Patient management**			
2.1	Patient management	Further patient management based on retinal findings	Nominal	1 = None/routine follow-up 2 = Report to GP 3 = Referral to GP 4 = Referral to ophthalmologist
3	**Retinal examination**			
3.1	Instruments	Available instruments for retinal examination	Nominal	
3.2	Method of retinal examination	Preferred method of retinal examination	Nominal	
3.3	Retinal examination in diabetes	Preferred method of retinal examination in patients with diabetes	Nominal	
3.4	Retinal imaging	Available instruments for retinal imaging	Nominal	
4	**Optometrist**			
4.1	Gender		Nominal	1 = male 2 = female
4.2	Work experience	Number of years in optometric practice	Interval	Years
4.3	Academic background	Highest academic degree in optometry	Ordinal	1 = technical college 2 = 2 year university college 3 = 3 year university college 4 = BSc 5 = MSc 6 = PhD
4.4	Specialist competency	Accredited to use diagnostic drugs	Nominal	1 = yes 2 = no