Celebrating 50 years of optometry education in Norway

We are nearing the end of 2022. The year when the Norwegian optometry education celebrated 50 years of innovation and excellence. Congratulations, Norway!

During these 50 years the professional education has gone from being a craft to becoming a health care profession with education at bachelor's, master's and doctoral level. It all started in Kongsberg in 1972, with a 2-year vocational training program in optics at Tinius Olsens Tekniske School under the leadership of Jacob Kjell Hultgren. In 1977, this became a 2-year engineering college level degree program, which was extended to a 3-year degree program in 1987. This took place under the leadership of Kjell Inge Daae, a visionary leader who motivated and inspired many of today's staff to travel to the UK, Australia and Canada to build on their education and later to work towards and obtain PhDs. He understood the need for the education to be research-based and the need to have staff that engaged in research as an integrated part of the education program.

Fast-forward to 2003 and the education has developed. It became a 3-year bachelor's degree program in optometry under the leadership of Janne Dugstad and now for the first time recognised as a health education. In 2004 the Norwegian authorities followed suit and gave optometrists, under Norwegian law, the right to use selected diagnostics drugs. This was of major benefit to patients and was strengthened in 2009 when optometrists also gained the right to refer directly to ophthalmologists. The optometry education received accreditation for a master's degree program in visual science in 2008, a program that was revised and accredited as master's in optometry and visual science in 2012. This happened under the leadership of Bente Monica Aakre, the current and first head of department with a PhD.

The optometry education continued to develop and became part of an interdisciplinary PhD program in person-centered healthcare that gained accreditation in 2014. This was the same year that accreditation was obtained for an interdisciplinary master's in vision rehabilitation. All these education programs became university degree programs in 2018 when the institution became the University of South-Eastern Norway.

During these 50 years, more than 1700 optometrists have graduated, of which more than 450 have also completed a master's degree. The education is continuing to develop, and the next step is to develop the 3+2-year (BSc + MSc) programs into an integrated 5-year master's program to meet the increasing needs of eye care professionals in Norway.

The speed of the development of the education program in Norway has been possible because a total of 24 optometrists, who have taken all or parts of their optometry education in Kongsberg, have also gained PhDs. The most recent have obtained their degrees at the home intuition, but many have spent several years abroad at different international institutions before returning to Kongsberg. The Norwegian optometry education has by now fostered 5 professors and the sixth professor of optometry in the Nordic countries also obtained his first degree in Kongsberg.

The golden jubilee of the Norwegian optometry education was celebrated during this year's Kongsberg Vision Meeting, on the 8th of November. The abstracts are published in this issue, and you will read that the meeting focused on the importance of gaining knowledge about refractive errors, visual function, and eye disease in different populations of different regions of the world. In turn, this should improve the knowledge among clinicians and, therefore, the outcome for patients.

Celebrating 50 years of optometry education in Norway. Current and previous academic leadership of the optometry education. From left to right: Professor Emeritus and previous rector Gunnar Horgen, Head of Department Bente Monica Aakre, Dean of Faculty of Health and Social Sciences Pia Cecilie Bing-Jonsson, Rector of University of South-Eastern Norway Professor Petter Aasen, Previous Head of Department Kjell Inge Daae. Photo: Jan Henrik Kulberg

The prevalence data for refractive errors in Scandinavia is an important example in that it shows that the distribution of refractive errors is different here than in other regions of the world. The high prevalence of hyperopia highlights the need to use cycloplegic drugs in clinical practice to ensure that a child with hyperopia is in fact diagnosed and treated for hyperopia. This topic was given special attention with an excellent keynote entitled "The importance of correcting hypermetropia" by Prof. Bruce Moore from New England College of Optometry.

The topic of the importance of wearing glasses if you need them was underlined by Lee Turner from the Department for Education, His Majesty's Government, UK. He told us about the reasons for and the results of a large randomised clinical trial that is nearing its end, "Glasses in Classes", whereby the first results show that children who need glasses and who wear them perform better in school with significantly improved literacy skills compared with those who need glasses but do not wear them. Prof. Solfrid Bratland-Sanda emphasised the role optometrists have in promoting healthy behavior amongst children and adolescents. Prof. Vibeke Sundling spoke about the topic of person-centered communication in clinical practice, a topic which is essential for ensuring that the patients' needs, values and preferences guide clinical decision making.

In this issue you can also read a paper by Bjørset and colleagues (Bjørset et al., 2022) in which they compare different refractive error screening methods in children, showing the role cycloplegic drugs play in detecting all hyperopes. This highlights the importance of mastering retinoscopy as a clinical skill, as well as the need for us to work globally to ensure that optometrists get access to cycloplegic drugs.

The issue also contains the abstracts from the first Norwegian Vision in Stroke (NorVIS) young researchers conference (Falkenberg, 2022).

We now also announce a third special topic. We encourage optometrists, researchers, and related professionals to submit their work to be considered for publication in a *SJOVS* standard issue over a two-year period. If accepted, manuscripts will be included in the online collection of the given special topic. The third special topic is going to be: patient-reported outcome measures (PROMS). The special topic editorial on PROMS is authored by associate editors António Filipe Macedo, Alberto Recchioni and Helle K. Falkenberg (Macedo et al., 2022).

On behalf of SJOVS, we wish you all a safe and peaceful winter.

Editor-in-Chief Rigmor C. Baraas
Associate Editor António Filipe Macedo

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Macedo, A. F., Recchioni, A., & Falkenberg, H. K. (2022). What are patient-reported outcome measures and why should optometrists care about them? *Scandinavian Journal of Optometry and Visual Science*, *15*(2). https://doi.org/doi:10.15626/SJOVS.vol15i2.3646

What are patient-reported outcome measures and why should optometrists care about them?

In times of person-centred eye care, patient-reported outcome measures (PROMS) are (or should be) in high demand. This is because many relevant eye problems of modern society have no specific, objective test that can reflect the patient's symptoms. Therefore, symptoms as measured with the best available PROMS remain the "gold standard test" for diagnosing conditions such as computer vision syndrome (CVS). PROMS can also be used as the main outcome measure in clinical trials when other tests are unresponsive to the interventions tested (Hernández-Moreno et al., 2022; E. Pearce et al., 2011).

Most optometrists and practitioners in related professions have little competence on how scales for symptoms are developed, partly because this aspect has received little attention during their education. Therefore, good quality guidance for optometrists is necessary. Even researchers seem to have incomplete understanding of existing scales or PROMS and tend to misuse them. An example is the use of the Ocular Surface Disease Index (OSDI), a very popular scale to assess symptoms of ocular disease problems (Roth et al., 2022) that was initially developed by Schiffman et al. (2000). Despite lacking validation for use in children, it has been used for that age category in what are expected to be high quality studies (Chen et al., 2021). Further, clinicians and researchers seem to confound validity with reliability despite the knowledge that one can exist without the other. For example, some studies recommend the use of dry eye scales that have been developed for adults to be used in children immediately after checking for the repeatability (Chidi-Egboka et al., 2021). However, they seem to forget that the scales also need to be valid.

Another example is the Convergence Insufficiency Symptoms Survey (CISS) developed by Borsting et al. (1999). Children with, for example, ADHD are expected to achieve different scores than children without that diagnosis. Despite this, there are anecdotal reports of clinicians still using CISS norms as a reference in all types of cases (Barnhardt et al., 2012). That is, the same cut-off values for CISS are used in children with pure binocular vision problems, children with dyslexia and/or ADHD and all mixed together. The very simple problem here is, how much attention will be paid to the text in the scale? How does, for example, dyslexia interfere with the interpretation of the questions? What is the concept of grading problems in a grading scale 1–5 for a 6- or 7-year-old child? These facts show how important it is to inform the community on how PROMS work and their limitations while, at the same time, addressing the unmet needs for new scales in eye care.

New PROMS may be necessary to, for example, measure comfort and perceived quality of vision in children wearing contact lenses, for dry eye and digital eye strain in children, and for binocular vision problems in children with "competing diagnoses".

In the next issues of *SJOVS* we would like to hear from the community on how clinicians and researchers embrace PROMS and if they are ready to use scales in their practice in the same way they use objective tests. Clinicians must keep in mind that patients care about what and how they feel, and that is often different from what is anticipated based on measurements using machines or clinical observations. It is important to move away from isolated questions during assessments of complex clinical conditions without clear gold standard tests. Awareness, correct use of scales, and development of new scales for the unmet needs should improve patient and clinician satisfaction with the quality of eye care that is provided. Articles on emerging issues are welcome and they may include original studies or literature reviews on the need for new or better PROMS in optometry and eye care.

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Non-cycloplegic refraction cannot replace cycloplegic refraction when screening for refractive errors in children

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Abstract

The purpose of this study was to assess the differences in spherical equivalent refractive error (SER) assessed by commonly used screening methods: cycloplegic autorefraction (1% cyclopentolate), non-cycloplegic autorefraction, and non-cycloplegic retinoscopy in a population with a high prevalence of hyperopia. Refractive error was measured with the three methods in 111 children aged 7–8 and 10–11 years. Bland-Altman analysis was used to assess the mean of the differences (*MD*) and the 95% limits of agreement (LoA) between cycloplegic autorefraction and the two non-cycloplegic methods. A mixed effects model was used to investigate the differences between methods by refractive group. Cycloplegic autorefraction gave a significantly more positive SER than both non-cycloplegic retinoscopy ($MD = 0.47$ D, LoA = −0.59–1.53 D) and non-cycloplegic autorefraction ($MD = 0.92$ D, LoA −1.12–2.95 D). The mean differences in SER increased with increasing degree of hyperopia [$F(4, 215) = 12.6$, $p < 0.001$], both when comparing cycloplegic refraction with non-cycloplegic retinoscopy and non-cycloplegic autorefraction.

Non-cycloplegic retinoscopy and autorefraction result in significantly less positive SER than cycloplegic autorefraction. The wide confidence intervals for the mean difference and limits of agreement are clinically unacceptable and the methods cannot be used interchangeably. Consequently, refraction without cycloplegia would cause misdiagnosis in some children. Even if non-cycloplegic retinoscopy results in narrower limits of agreement, the risk of misdiagnosis is not eliminated by being experienced in carrying out retinoscopy. We show that it is essential to use cycloplegia when refracting children, particularly in a population with a high prevalence of hyperopia, to ensure that no hyperope goes undetected.

Keywords: Children, cycloplegic autorefraction, non-cycloplegic autorefraction, non-cycloplegic retinoscopy, cyclopentolate

Introduction

The clinical value of cycloplegia is often overlooked by practitioners, who frequently omit its use during refraction, which may lead to an underestimation of hyperopia or overestimation of myopia (e.g. (Doherty et al., 2019; Fotedar et al., 2007; Sun et al., 2018; Zhao et al., 2004)). In children, cycloplegic refraction is considered essential in epidemiological studies and the gold standard in clinical practice (American Optometry Association, 2017; Morgan et al., 2015). It is known that uncorrected refractive errors can affect daily life and academic achievement (Kulp et al., 2016; Mavi et al., 2022; Neitzel et al., 2021; Williams et al., 2005), and hence it is important that refractive errors are detected, accurately assessed, and corrected when needed. The most common refractive error in children in Norway, Sweden, and Denmark is hyperopia (Demir et al., 2021; Hagen et al., 2018; Sandfeld et al., 2018), which is different from that reported in children from South-East Asia, East Asia, and the Western Pacific region (Hashemi et al., 2018).

In a review, L. B. Wilson et al. (2020) showed that there is good agreement between cycloplegic autorefraction and cycloplegic retinoscopy, but non-cycloplegic autorefraction had a propensity to give more negative results than cycloplegic autorefraction in children. Few studies have compared retinoscopy with and without cycloplegia in school-aged children. A Northern-Irish study of children aged 6–13 years revealed more positive refraction in all age groups when comparing cycloplegic with non-cycloplegic retinoscopy, with a mean difference of 0.59 D (Doherty et al., 2019). The greatest difference was found for the younger children and children with higher degrees of hyperopia. The same study reported non-cycloplegic hyperopia of ≥ +1.5 D to have high sensitivity and specificity for revealing clinically significant hyperopia (≥ +2.5 D after administering 1% cyclopentolate). A Norwegian study found significantly higher degrees of hyperopia (0.5 D) after cycloplegia (cyclopentolate 1%) in children aged 10–15 years (Thorud et al., 2021). Some studies have found good inter- and intra-repeatability of cycloplegic retinoscopy in children for experienced clinicians (Hirsch, 1956; McCullough et al., 2017), although cycloplegic autorefraction typically gives higher repeatability than cycloplegic retinoscopy (Fotouhi et al., 2012; Nilsen et al., 2022; Sankaridurg et al., 2017; Zadnik et al., 1992). Clinical studies show considerable between-individual variation when non-cycloplegic and cycloplegic refraction methods are compared (L. B. Wilson et al., 2020).

It is essential to know the cycloplegic refractive error prior to deciding the best treatment option, especially when dealing with children with hyperopia, amblyopia, and binocular and accommodative dysfunctions. Further, the need for more research concerning differences between non-cycloplegic and cycloplegic refraction for different refractive errors in different age groups was pointed out in a recent systematic review (S. Wilson et al., 2022). The purpose of this study was to assess differences in commonly used screening methods for assessing refractive errors; non-cycloplegic retinoscopy performed by an experienced optometrist, non-cycloplegic autorefraction, and cycloplegic autorefraction in primary school children in South-East Norway. Importantly, this study contributes to increasing knowledge about differences in cycloplegic and non-cycloplegic refraction in children in a population where the prevalence of hyperopia is high.

Materials

Study population, recruitment, and participants

A cross-sectional study was performed in 2020 and 2021 for children aged 7–8 and 10–11 years in a primary school in Kongsberg Municipality, as part of a school vision testing program run by The National Centre for Optics, Vision and Eye Care (NCOVE) at the University of South-Eastern Norway. All children were invited, and 111 children (50%) participated. The ethnicity of the children was not recorded, but the majority were Caucasian. The population of Kongsberg is ethnically and socio-demographically representative of Norway (see additional information of Hagen et al. (2018)). Written informed consent from both parents was required for inclusion in the study. Written and oral explanations of the purpose and the procedures of the study were given and approved by the Regional Committees for Medical and Health Research Ethics (REC) in South East Norway. The research was conducted in accordance with the tenets of the Declaration of Helsinki.

Procedures

Non-cycloplegic retinoscopy was obtained by two optometrists with more than 20 years experience of performing retinoscopy in children. A standard retinoscopy procedure was performed through a +1.5 D lens using a manual phoropter, neutralising the spherocylindrical refractive error. The children viewed a large letter or another suitable non-accommodative object at a distance of at least 6 metres. Non-cycloplegic and cycloplegic autorefraction were performed utilising the Huvitz HRK-8000A Auto-REF Keratometer (Huvitz Co. Ltd., Gyeonggi-do, Korea), which has been shown to have high repeatability (Nilsen et al., 2022). Results from autorefraction were automatically calculated from five measurements. The cycloplegic autorefraction was done 30–40 minutes after administering Cyclopentolate 1% (Minims single dose; Bausch & Lomb UK Ltd., Kingston, England). Children with blue or green eyes received one drop, whereas those with hazel to brown eyes received two drops in each eye.

Analyses

Spherical equivalent refractive error (SER) was calculated (SER = sphere + ½ cylinder). Myopia was defined as SER ≤ −0.50 D, emmetropia as −0.50 D < SER < +0.50 D, low hyperopia as +0.50 D ≤ SER < +2.00 D, and moderate-to-high hyperopia as SER ≥ +2.00 D. Refractive astigmatism was defined as ≥ 0.75 DC. Mean, standard deviation (*SD*), and total range for retinoscopy, and autorefraction with and without cycloplegia were summarised for all participants and the two age groups. Cycloplegic autorefraction was used to investigate the frequency and distribution of refractive errors. A Welch two-sample *t*-test was used to assess mean cycloplegic refractive error for each age group. Boxplots and Bland-Altman plots with 95% limits of agreement (LoA) and 95% confidence intervals (CI) were used to assess the agreement between cycloplegic autorefraction and the two non-cycloplegic methods. A linear mixed model analysis of variance and post hoc pairwise comparisons, based on model estimated marginal means and standard errors (*SE*), were used to analyse the mean differences in SER between refraction methods by refractive group. To obtain a sufficient number in each group, the myopia and emmetropia group were combined. The *p*-values were adjusted for multiple comparisons using Bonferroni correction. A statistical difference was set to $p < 0.05$ (two-tailed). Statistical analyses were performed in R statistical software version 4.2.1 (R Core Team, 2021), including the package lme4 version 1.1-30 (Bates et al., 2015).

Results

In total, 111 children participated (45% females), 53 (48%) were aged 7–8 years, and 58 (52%) were aged 10–11 years. There was no difference in mean cycloplegic SER between the right and the left eye ($t(110) = −0.26$, $p = 0.80$), thus the right eye was used for further analyses. Table 1 shows the demographic and cycloplegic refractive error data. Of the children aged 7–8 years, 94% had hyperopia, 2% had emmetropia and 4% had myopia. Of the children aged 10–11 years, 88% had hyperopia, 10% had emmetropia and 2% had myopia. The mean cycloplegic refractive errors for the children aged 7–8 years and 10–11 years were +1.27 ± 0.75 D and +1.40 ± 1.58 D, respectively, and reflect a higher number of high hyperopes among the 10–11-year-olds (see Table 2). There was no statistically significant difference in mean SER between the age groups ($t(82.87) = −0.57$, $p = 0.57$), nor between males and females ($t(107.08) = 0.72$, $p = 0.47$) for either age group (7–8 years ($t(50.44) = 1.60$, $p = 0.17$), 10–11 years ($t(55.91) = 0.10$, $p = 0.91$)).

Comparison of refractive methods

Figure 1 shows Bland-Altman plots for comparison between cycloplegic autorefraction and the two non-cycloplegic refraction methods. The mean difference (95% CI) between cycloplegic autorefraction and non-cycloplegic retinoscopy was 0.47 D (0.37, 0.57) with 95% LoA (95% CI) −0.59 D (−0.77, −0.42) to 1.53 D (1.35, 1.70). The mean difference (95% CI) between cycloplegic and non-cycloplegic autorefraction was 0.92 D (0.72, 1.11) with 95% LoA (95% CI) −1.12 D (−1.45, −0.78) to 2.95 D (2.61, 3.28). The wide LoAs indicate a larger individual difference between cycloplegic and non-cycloplegic autorefraction (see Figure 1).

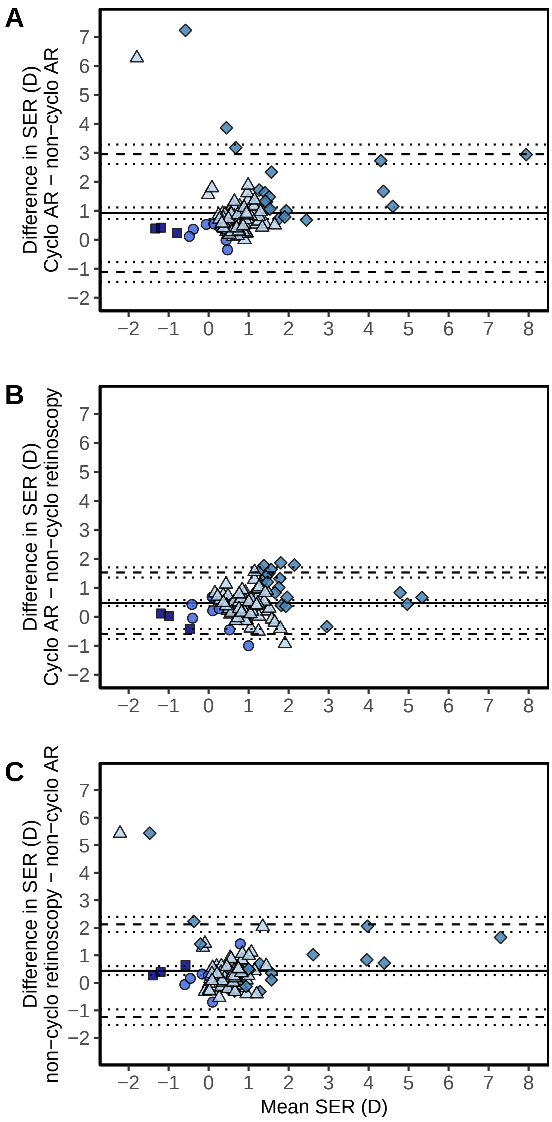

Figure 1: *Bland Altman plots showing agreement of SER between (A) cycloplegic autorefraction (cyclo AR) and non-cycloplegic autorefraction (non-cyclo AR), (B) cycloplegic autorefraction and non-cycloplegic retinoscopy, and (C) non-cycloplegic retinoscopy and non-cycloplegic autorefraction, for all participants. The difference of the two paired measurements is plotted against the mean, the mean represented by the x-axis, and the difference by the y-axis. The solid black line represents the mean of the differences, the dashed lines represent the upper and lower LoAs (95%), and the dotted lines represent 95% CI around the mean differences and the LoAs. Symbols: myopia = squares, emmetropia = circles, low hyperopia = triangles, moderate-to-high hyperopia = diamonds.*

Table 2 shows mean SER across the different refraction methods. The mean SER difference between the three refraction methods was largest for moderate-to-high hyperopia and small-

Table 1: *Cycloplegic spherical equivalent refractive errors (SER) from autorefraction (right eye, n = 111) categorized by age and sex of both age groups and by type of refractive error.*

Age (years)	Group	n	Cycloplegic SER [D] Mean (SD)	Range	Cycloplegic refractive error type [%] Myopia	Emmetropia	Low hyperopia	Moderate-to-high hyperopia	Astigmatism
7–8	All	53	1.27 (0.75)	–0.98–3.03	3.8	1.9	77.4	17.0	11.3
	Female	26	1.43 (0.68)	–0.43–2.38	0.0	1.9	34.0	13.2	3.8
	Male	27	1.11 (0.79)	–0.98–3.03	3.8	0.0	43.4	3.8	7.5
10–11	All	58	1.40 (1.58)	–1.14–9.41	1.7	10.3	70.7	17.2	6.9
	Female	24	1.43 (1.30)	0.30–5.20	0.0	6.9	25.9	8.6	5.2
	Male	34	1.38 (1.87)	–1.14–9.41	1.7	3.5	44.8	8.6	1.7

Note: Myopia was defined as SER ≤ –0.50 D, emmetropia as –0.50 D < SER < +0.50 D, low hyperopia as +0.50 D ≤ SER < +2.00 D, moderate-to-high hyperopia as SER ≥ +2.00 D and astigmatism ≥ 0.75).

est for emmetropia and myopia (see Figure 2). The mixed model analysis revealed a significant difference in mean SER between the three refraction methods [$F(2, 215) = 47.1$, $p < 0.001$]. The interaction between refraction method and refractive group was significant [$F(4, 215) = 12.6$, $p < 0.001$]. Post hoc pairwise comparisons showed no difference in mean SER values between cycloplegic autorefraction and non-cycloplegic retinoscopy in myopia and emmetropia (difference in estimated marginal means ± SE: −0.022 ± 0.24, $p = 1.00$). However, there were differences for the low hyperopia (0.39 ± 0.08, $p < 0.001$) and the moderate-to-high hyperopia (1.06 ± 0.17, $p < 0.001$) groups, showing a significant underestimation of hyperopia with non-cycloplegic retinoscopy. Non-cycloplegic autorefraction gave a less positive SER than the other two methods for all refractive error groups, also diverging further with increasing hyperopia: the estimated mean difference ± SE between cycloplegic autorefraction and non-cycloplegic autorefraction was significant for low hyperopia (0.74 ± 0.08, $p < 0.001$) and moderate-to-high hyperopia (1.99 ± 0.17, $p < 0.001$), but not for emmetropia and myopia (0.26 ± 0.24, $p = 0.84$). Analysis showed that there was no significant difference between the two optometrists who performed the non-cycloplegic retinoscopy ($t(32) = 1.63$, $p = 0.11$)).

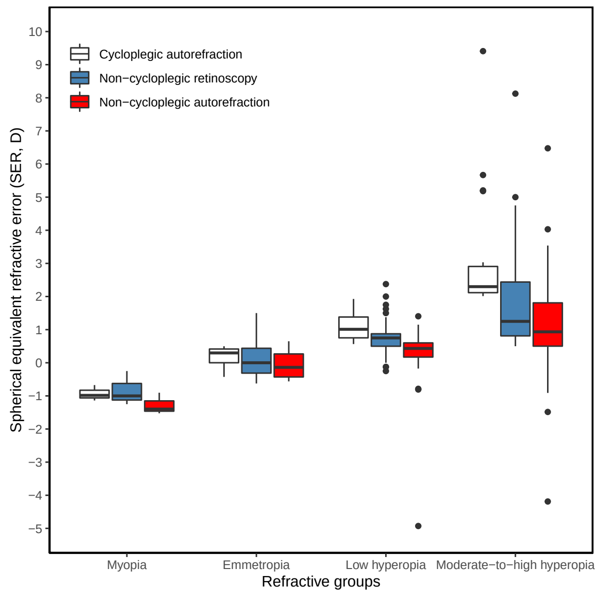

Figure 2: *Boxplot displaying SER data for the three different refraction methods (cycloplegic autorefraction, non-cycloplegic retinoscopy, and non-cycloplegic autorefraction, represented by white, blue, and red, respectively) classified by the four refractive groups: myopia, emmetropia, low hyperopia and moderate-to-high hyperopia. The 25–75 quantile (interquantile range, IQR) is represented by the height of the box, and the black line represents the median. The whiskers correspond to the range of the refractive measurement, except for the outliers (observations outside 1.5*IQR), which are represented by the black dots.*

Astigmatism ≥ 0.75 DC was found in ten children (9%), six (5.4%) of whom were aged 7–8 years. There was no statistically significant difference in mean cylinder power between cycloplegic and non-cycloplegic autorefraction ($t(109) = 0.49$, $p = 0.62$). There was a statistically significant difference in mean cylinder power between cycloplegic autorefraction and non-cycloplegic retinoscopy ($t(110) = -4.67$, $p < 0.001$, mean difference −0.15 DC). This was the case also between non-cycloplegic autorefraction and non-cycloplegic retinoscopy ($t(109) = -5.06$, $p < 0.001$, mean difference −0.16 DC).

Discussion

Here we show that there was no systematic relationship between non-cycloplegic and cycloplegic measures of refraction in a population with a high frequency of hyperopia. Even if cycloplegic autorefraction showed statistically and clinically significantly more positive SER than both non-cycloplegic autorefraction (0.92 D) and non-cycloplegic retinoscopy (0.47 D), it is not possible to predict which children would need cycloplegic refraction based on non-cycloplegic refraction alone. Importantly, there was an increase in the difference between cycloplegic and non-cycloplegic methods with more positive SER (see 2), which has major implications in a population where the frequency of hyperopia is high. The difference between cycloplegic and non-cycloplegic refraction was considerable. It should be emphasised that the results are part of a school vision testing protocol, and our findings are discussed in a screening context. These methods are regularly used as part of clinical examination where subjective refraction is the gold standard for prescribing. Omitting cycloplegic refraction may impact clinical judgment when prescribing glasses, and the associated risk is that children may be prescribed the wrong treatment (i.e., optical correction, myopia control, visual training, follow-up). In turn, this could affect academic performance and everyday life.

The difference in results between cycloplegic and non-cycloplegic methods was expected as a few studies have already demonstrated that the administration of cycloplegic drugs prior to measuring refraction, independent of method, results in a more hyperopic refraction (Choong et al., 2006; Doherty et al., 2019; Fotouhi et al., 2012; Hashemi et al., 2016; Kirschen & Isenberg, 2014). L. B. Wilson et al. (2020) reported refraction to be up to 2.0 D more hyperopic for cycloplegic than for non-cycloplegic autorefraction in children. More specifically, our results regarding the comparison of cycloplegic and non-cycloplegic autorefraction are comparable with the results from an Australian study in children aged 6 years and 12 years (mean SER difference 1.18 D and 0.84 D, respectively) (Fotedar et al., 2007). Studies in countries with a higher prevalence of myopia have reported smaller differences, including a study in Chinese children aged 4–15 years (0.63 D) (Sankaridurg et al., 2017), and

Table 2: *Measurements of spherical equivalent refractive error (SER) across different refraction methods.*

		Cycloplegic Autorefraction SER [D]		Non-cycloplegic Autorefraction SER [D]		Non-cycloplegic Retinoscopy SER [D]	
Age (years)	*n*	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
All	111	1.34 (1.25)	−1.14–9.41	0.42 (1.17)	−4.93–6.48	0.87 (1.12)	−1.25–8.13
7–8	53	1.27 (0.75)	−0.98–3.03	0.28 (0.86)	−4.19–1.52	0.73 (0.59)	−1.00–2.38
10–11	58	1.40 (1.58)	−1.14–9.41	0.54 (1.39)	−4.93–6.48	1.00 (1.44)	−1.25–8.13

Note: Measurement of non-cycloplegic autorefraction is missing for one participant.

Iranian children aged 5–10 years (0.71 D) (Fotouhi et al., 2012). However, these studies are from populations with a higher frequency of myopic children than that reported in Scandinavian countries (Demir et al., 2021; Hagen et al., 2020; Sandfeld et al., 2018). Our results for differences between cycloplegic autorefraction and non-cycloplegic retinoscopy were in line with a study comparing cycloplegic and non-cycloplegic retinoscopy in a similar age group (6–13 years) of Northern-Irish children with mean sphere differences of 0.59 D (Doherty et al., 2019). A study of Chinese children (3–5.5 years) in Hong Kong found larger differences, but the participants were younger compared to our study (Chan & Edwards, 1994).

Non-cycloplegic autorefraction deviated from cycloplegic autorefraction across all groups of refractive errors. While non-cycloplegic retinoscopy was more accurate for myopia and emmetropia, hyperopia was underestimated, and particularly moderate-to-high hyperopia. This is in line with other studies that found a larger deviation in higher hyperopia with non-cycloplegic than cycloplegic refraction (Doherty et al., 2019; Morgan et al., 2015; Sankaridurg et al., 2017). However, there were few participants in the myopia and emmetropia groups. Comparison of results across studies was constrained by the variety of experimental protocols in different studies comparing non-cycloplegic and cycloplegic results, including different age groups, populations, types of autorefractors, and other experimental procedures. Regardless of these limitations, the weight of evidence suggests that non-cycloplegic autorefraction and retinoscopy tend to underestimate hyperopia, and overestimate myopia (Choong et al., 2006; Doherty et al., 2019; Hashemi et al., 2016; Kirschen & Isenberg, 2014). The LoAs were wide and considerably wider for the difference between cycloplegic and non-cycloplegic autorefraction (−1.12 to 2.94 D) than between cycloplegic autorefraction and non-cycloplegic retinoscopy (−0.59 to 1.53 D). These results highlight the importance of using cycloplegia for every child to provide the correct refractive prescription, as has been stated in by other researchers (Fotedar et al., 2007; Fotouhi et al., 2012; Sankaridurg et al., 2017).

Omitting cycloplegic refraction implies a risk of undercorrecting hyperopic children, and even prescribing myopic correction in severe cases. The consequence can be that a hyperopic child is prescribed with a lower prescription than required, with the risk of not experiencing the full benefit of their correct prescription, not prescribed prescription at all, or given glasses for reading and part-time use when they, both in developmental and educational terms, would have benefitted from constant use (Bruce et al., 2018; Ma et al., 2014). A hyperopic refractive error may be disguised as an accommodative or binocular disorder, and the child may be provided with unnecessary near vision addition lenses or orthoptic training. A child wrongly classified as myopic may be at risk of receiving unnecessary treatments, e.g., given minus prescription or even myopia control. A wrong correction can lead to asthenopia such as headache, eyestrain, double vision, or blur, especially when the child is performing cognitively demanding tasks (Kulp et al., 2016; Neitzel et al., 2021; Williams et al., 2005). Wrong or unnecessary treatments impose increased costs, expenses, and time consumption, and may be detrimental for the child in terms of educational attainment.

Strengths and limitations

A strength in this study is that the participants included were unselected children from two school-years at a representative school in the municipality. A limitation may be that the effect of cycloplegia was not objectively assessed. However, measurements were performed 30–40 minutes after instillation of cycloplegic drops. Further, a high proportion of children have light iris pigmentation in Norway, like in other Northern European countries, and previous research has suggested that there is a significant effect of cycloplegia in persons with light irises as early as 10 minutes after the instillation of cyclopentolate 1% (Manny et al., 1993). Still, if full cycloplegic refraction was not obtained in every child, it is likely that the cycloplegic refraction would have been further skewed towards hyperopia, strengthening our findings.

Conclusion

The mean differences and the 95% limits of agreement between non-cycloplegic retinoscopy and autorefraction were too wide to ensure correct refractive error diagnosis. The risk of misdiagnosis increases with the degree of hyperopia. For hyperopes, in particular, the results show that there are unforeseen between-individual differences in the effect of cycloplegia, rendering the non-cycloplegic measures unreliable. This emphasises the importance of cycloplegic refraction as the preferred method when refracting children.

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Ikke-cycloplegisk refraksion kan ikke erstatte cycloplegisk refraksjon ved screening for refraktive feil hos barn

Sammendrag

Hensikten var å vurdere forskjellene i refraktive feil (sfærisk ekvivalent refraksjon, SER) målt med mye brukte screeningsmetoder: cycloplegisk autorefraksjon (1% cyclopentolat), ikke-cycloplegisk autorefraksjon og ikke-cycloplegisk retinoskopi i en populasjon med høy forekomst av hyperopi. Refraktiv feil ble målt med de tre metodene hos 111 barn i alderen 7–8 og 10–11 år. Bland-Altman-analyse ble brukt til å vurdere forskjellene i gjennomsnitt (*MD*) og 95% samsvarsgrenser (LoA) mellom cycloplegisk autorefraksjon og de to ikke-cycloplegiske metodene. En blandet effektmodell ble brukt til å undersøke forskjellene mellom metodene for de ulike refraktive gruppene. Cycloplegisk autorefraksjon ga en signifikant mer positiv SER enn både ikke-cycloplegisk retinoskopi (MD = 0,47 D, LoA = -0,59–1,53 D) og ikke-cycloplegisk autorefraksjon (MD = 0,92 D, LoA -1,12–2,95 D). De gjennomsnittlige forskjellene i SER økte med økende grad av hyperopi [$F(4, 215) = 12{,}6$, $p < 0{,}001$], både ved sammenligning av cycloplegisk refraksjon med ikke-cycloplegisk retinoskopi og med ikke-cycloplegisk autorefraksjon.

Ikke-cycloplegisk retinoskopi og autorefraksjon gir betydelig mindre positiv SER enn cycloplegisk autorefraksjon. De brede konfidensintervallene for den gjennomsnittlige forskjellen og samsvarsgrensene er klinisk uakseptable, og metodene kan ikke brukes om hverandre. Følgelig vil refraksjon uten cycloplegi forårsake feildiagnostisering hos noen barn. Selv om ikke-cycloplegisk retinoskopi gir smalere samsvarsgrenser, elimineres ikke risikoen for feildiagnostisering ved å ha erfaring med å retinoskopere. Vi viser at det er viktig å bruke cycloplegi ved refraksjon av barn, spesielt i en populasjon med høy forekomst av hyperopi, for å sikre at ingen hyperope forblir uoppdaget.

Nøkkelord: Barn, cycloplegisk (våt) autorefraksjon, ikke-cycloplegisk (tørr) retinoskopi, cyclopentolate

La refrazione non cicloplegica non puo' sostituirsi alla refrazione cicloplegica nel rilevamento degli errori refrattivi nei bambini

Riassunto

Lo scopo di questo studio e' stato quello di verificare le differenze nell'errore come equivalente sferico (SER) considerando metodi comuni di screening; autorefrazione con cicloplegico (1% ciclopentolato), autorefrazione senza cicloplegico e retinoscopia senza cicloplegico in una popolazione con alta prevalenza di ipermetropia.

L'errore refrattivo e' stato misurato con i 3 metodi in 111 bambini di eta' tra i 7 e gli 8 anni e tra i 10 e gli 11 anni. L'analisi Bland-Altmas e' stata considerata per verificare la media delle differenze (*MD*) e il limite al 95% di accordo (LoA) tra la autorefrazione con cicloplegico e i due metodi senza cicloplegico. Un modello ad effetto misto e' stato considerato per ricercare le differenze tra i metodi nei gruppi refrattivi.

L'autorefrazione con cicloplegico ha riportato un valore piu positivo di SER rispetto ad entrambe retinoscopia senza cicloplegico (MD = 0.47 D, LoA = -0.59–1.53 D) ed autorefrazione senza cicloplegico (MD = 0.92 D, LoA of -1.12–2.95 D). La differenza media del SER e' aumentata con l'aumentare del grado di ipermetropia [$F(4, 215) = 12.6$, $p < 0.001$], comparando entrambe le tecniche con refrazione cicloplegica, retinoscopia senza cicloplegico e autorefrazione senza cicloplegico.

La retinoscopia senza cicloplegico e l'autorefrattometria risultano in valori significativamente meno positivi di SER rispetto all'autorefrazione con cicloplegico. Gli ampi intervalli di confidenza per la media e i limiti di accordo sono clinicamente inaccetabili e tali metodi non possono essere intercambiabili. Di conseguenza, la refrazione senza cicloplegico potrebbe causare diagnosi errate in alcuni bambini.

Anche se la retinoscopia senza cicloplegico rilsuta in valori piu' contenuti nei limiti di accordo, il rischio di errata diagnosi non e' eliminato dal fatto di eseguire la retinoscopia con esperienza. Abbiamo dimostrato che e' essenziale l'uso di cicloplegico per la refrazione in bambini, particolarmente in una popolazione con elevata prevalenza di ipermetropia, e per assicurare che l'ipermetropia non rimanga non rilevata.

Parole chiave: Bambini, autorefrazione con cicloplegico, refrazione senza cicloplegico, retinoscopia senza cicoplegico, ciclopentolato

Kongsberg Vision Meeting 2022: Abstracts

Kongsberg Vision Meeting was held at the University of South-Eastern Norway in Kongsberg, for the 14th time, on November 7–9, 2022. The meeting was organised as a three-day meeting with a lighting design day followed by two clinical optometry and vision research days. Rigmor C. Baraas, Sylvia Pont, Helle K. Falkenberg, Vibeke Sundling, Tove Lise Morisbakk, Gro Horgen Vikesdal, Lotte-Guri B. Steen, Trine Langaas, Randi Mork and Are Røysamb organised the three-day meeting. The theme this year was Light & Vision in a Public Health Perspective. Keynote speakers were Wout van Bommel for the lighting design day, and Bruce Moore and Vibeke Sundling for the research day. Lee Turner from the Department for Education, His Majesty's Government, UK and Mark Mon-Williams, University of Leeds and Bradford Institute of Health Research, UK held a special session on the randomised control trial (RCT) "Glasses-in-Classes", a project run in state-funded primary schools based in the Metropolitan area of Bradford (UK) to ensure that children who need eyeglasses both have access to an eye examination as well as to two pairs of glasses. Teachers are informed and trained to ensure children who have been prescribed glasses wear them at school, and that their spare pair is available if they attend school without their home pair. Preliminary results from the RCT show that wearing eyeglasses over one school year significantly improves reading and literacy skills when a child who needs eyeglasses wears them as compared with those who need eyeglasses, but do not wear them. The abstracts from the other invited and contributed talks on the different days are presented in the order they were given.

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What older people can not see while driving under road lighting of standard quality

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Abstract

Many ophthalmologists and opticians advise cataract surgery when the yellowing of the intraocular lens reaches the stage of the average lens yellowing of a 70-year-old. In my country, the Netherlands, insurance companies do not pay for cataract surgery at an earlier, less severe stage of lens yellowing. Compared to a 25-year-old, the amount of light reaching the retina of an average 70-year-old, at adaptation levels typical for road lighting, is reduced to about 30% due to the combined effect of yellowing of the lens and the smaller pupil, also characteristic of the elderly. Many ophthalmologists and opticians do not realise that this reduction has dramatic consequences for the older motorist while driving during hours of darkness. This also holds when the road has lighting according to international lighting standards (CIE or EN standards).

In my presentation, I will first describe the silhouette principle of road lighting that forms the background for today's luminance concept of road lighting for motorised traffic. The combination of road surface luminance level, luminance uniformity and glare restriction, determines the quality of a road lighting installation. For evaluating the visibility obtained with different road lighting qualities, the concept of "revealing power" is highly suitable. Revealing power is based on the visibility of a large set of 20×20 cm objects with reflections typical of winter clothing, viewed from a distance of 100 m. For example, road lighting with a lighting level of 1 cd/m^2 gives a revealing power value for a 30-year-old of around 80%, near the ideal situation of 100%. But revealing power can decrease to 0% for a 60-year-old under the same road lighting condition. Only when revealing power values are determined for shorter visibility distances are high enough values obtained. However, shorter visibility distances are only acceptable at lower driving speeds.

The biggest problem is probably that most "older" people do not realise that they see far too little to drive safely during hours of darkness, even under what generally is accepted as good road lighting. The elderly driver who does realise this has two options: stay at home or slow down! Slow driving drivers on high-speed motorways, of course, decrease the overall safety on the road. Based on these considerations, it seems wise to perform cataract surgery at an earlier stage of yellowing of the intraocular lens than what is common today.

Lighting in protected areas: a matter of fragile equilibrium

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Abstract

The lighting of protected areas has traditionally been approached from a perspective aimed to minimise light pollution. With this target the luminance levels requested by law are as low as possible, whereas the spectrum of the emitted light avoids blue wavelengths in order to decrease the Rayleigh scattering that impairs astronomical observations and interacts with wildlife in a wide variety of situations. However, little has been said about the safety, the performance and specifically the visual perception of the users of these areas under these lighting conditions. One remarkable particularity is the visual range itself, with a strong shift towards the segment of the mesopic field with lowest levels of illumination. Given the better visual performance of shorter wavelengths in that part of the mesopic field and the consequent decrease in the amount of flux emitted to ensure similar visual performance, an important question arises: can the lower installed power of white light somehow compensate the higher Rayleigh scattering despite the current recommendations? This question will be discussed in the present work.

Personalised lighting design

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Abstract

People's mood and performance may benefit from lighting that matches personal needs and preferences. Researchers are detangling optimal light (and dim) exposure to support human performance, likely including varying light (quality) doses through the day. Successively, tuneable lighting installations can be programmed to deliver light(ing) quality varying in amount (and spectral power distribution) to accommodate users' personal needs. However, for truly personalised lighting design, lighting *needs* may have to be combined with lighting *preferences*.

Generally, preferred illuminance averages are not clustered around the typically recommended practice level of, i.e., 500 lx.

On average, participants in research studies with dimming control chose slightly lower desktop illuminance values. A review of previous work showed that varying results were not a matter of preference but could be explained by stimulus range bias. Typically, the reported mean illuminance was about the midway point on the available range, not an actual preference estimate. Unfortunately, most studies often do not mention the lower and upper dimming limits. Additionally, a significant variation occurs among individuals around their average. In research studies, many participants chose illuminances that differed by more than 25–50% at various times of the day. Participants may, consciously or unconsciously, set a light level related to an internal biological clock. Alternatively, it can be a contrast balancing response to the increasing and decreasing daylight outside and the subsequently increasing and decreasing interior light level.

Nevertheless, personal(ised) lighting design should focus on more design parameters than just light(ing) quality / quantity (i.e., illuminance, luminance, spectral power distribution), as many more parameters directly or indirectly influence a room's personal lighting exposure / experience. For example, the light's incidence and spatial distribution, the preferred view to the outside, the choices of the wall, floor, and furniture finishings, the required privacy level, and the needed interaction with the rest of the space and other users are parameters of which people's preferences and needs can vary.

Most personal(ised) lighting design experiments are executed in working and learning environments. However, since light exposure for humans is essential when employees and students are still / already home (early morning, late afternoon, evening), research focuses on the work and the home environment. Typically, implementing personalised lighting design at home to fulfil people's personal *preferences* and — maybe more crucially — *needs* is an even larger challenge.

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The science and practice behind design for darkness strategies

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Abstract
Recognition of the adverse effects of artificial light at night, commonly referred to as light pollution, has spurred new design strategies aiming to foster sustainable and environmentally responsible urban lighting. This presentation will outline an emerging approach that re-frames discussions away from what is bad about artificial light at night, instead exploring what it means to value — and ultimately design for — darkness. It will outline the theoretical foundations of *design for darkness*, as well as how it can be translated into practical design and policy interventions. As a framework, it situates darkness as both an evaluative lens and a quality of lived experience, and relies on three interrelated core principles. First, darkening cities should be positioned as a means of urban (ecological) restoration akin to greening cities. Second is the adoption of a value-sensitive outlook, working to preserve and promote the positive ecological and social goods offered by darkness. Third, lighting design should strive to create the conditions for positive experiences of urban darkness, and in particular dark skies, through a reconsideration of nocturnal atmospheres. Building on this framework, we will present two strategies for translating design for darkness into practice: *dark acupuncture* and environmentally-responsive or *nature-inclusive* lighting. These will be exemplified via a collaborative project which established a design vision for an urban park in the Netherlands. To conclude, we will offer reflections on the collaborative process between an academic researcher and a practicing lighting designer, and how such co-operations can advance the theory and practice of designing for darkness.

The Importance of Correcting Hypermetropia

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Abstract
Hyperopia is essentially the "forgotten" refractive error, especially given the enormous current interest in myopia. Hyperopia is directly associated with astigmatism, anisometropia, amblyopia, and strabismus, which are all inter-related and major causes of vision impairment in young people. Furthermore, recent evidence shows that significant levels of hyperopia are intimately related to learning problems in children. The Vision In Preschoolers — Hyperopia In Preschoolers (VIP-HIP) Study and other recent research has shown that even 4 and 5 year old children with moderate to high degrees of hyperopia are already significantly adversely affected in their acquisition of preliteracy skills. There is thus a direct linkage between hyperopia and academic performance, and academic failure. So, not only from a disease perspective, but also from a learning perspective, hyperopia is a critically important refractive error that optometrists must be skilled in detecting and treating. We will discuss recent evidence concerning these relationships, the methods of detecting hyperopia through vision screening, and an approach to providing correction for hyperopia in children.

Vision anomalies and manual control in children and adolescents in Norway

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Abstract
In this study we explored the associations between vision anomalies and manual control in healthy children and adolescents. Manual control was assessed with the Leeds Clinical Kinematic Assessment Tool (CKAT (Flatters et al., 2014)) — a

tablet with a handheld stylus. During participation in the annual school vision program in Kongsberg municipality (Norway), girls and boys completed the CKAT test battery. The motor tasks that were assessed here consisted of i) making aiming movements in an invisible star-like pattern and ii) tracing two abstract shapes. The school vision program includes measurements of refractive errors, visual acuity, binocular vision, stereoacuity (TNO), ocular biometry and collecting medical history. Upon assessment of these results a decision about referral was made; if the results constituted either a suspicion and/or a discovery of eye or vision anomalies, the child was referred to the university eye clinic or to their own eye care practitioner. One in four children were referred. The referred and non-referred children were compared against their CKAT results, using Welch's *t*-test for statistical analysis. Children who were referred performed significantly poorer in the aiming task, but not in the tracing task. The results add to cumulating evidence that having a common vision anomaly may have a negative impact on specific aspects of an individual's degree of manual control. Further research is needed to substantiate the findings and to investigate whether there are secondary effects on learning.

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Longitudinal changes in peripheral refraction in a cohort of Swedish schoolchildren

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Abstract

Research in animals has shown that central refractive changes may be regulated by peripheral retinal defocus (Huang et al., 2011). However, research in humans on the impact of peripheral defocus on ocular growth has been inconclusive. Ideally, a longitudinal follow up of peripheral refraction in children might elucidate the role of peripheral retina in regulating ocular growth in humans. Therefore, the aim of this study was to follow a cohort of Swedish schoolchildren for a period of two years and investigate changes in peripheral refraction. In addition, we investigated whether peripheral hyperopic defocus at the initial visit was a risk factor for development of myopia.

The right eyes of 120 children (55% females) with mean age of 12.0 years (*SD* 2.4) were followed up for a period of 2 years. Cycloplegic central and peripheral refraction obtained at the initial and final visits were used to investigate changes in refraction. Central and peripheral refraction was obtained with Shin-Nippon NVision-K 5001 autorefractor along the horizontal meridian (nasal and temporal) out to 30° in 10° steps. Refraction was recalculated into M, J_0 and J_{45} vectors for analyses. Relative peripheral refraction was calculated by subtracting the central measurement from each peripheral measurement. Children were assigned to three refractive categories based on the central spherical equivalent refraction (SER−M) at the initial visit. Hyperopia was defined as SER $\geq +0.75$ D, myopia was defined as SER ≤ -0.50 D and emmetropia was defined as SER between -0.49 D to $+0.74$ D.

At the initial visit there were 56 children with hyperopia, 10 children with myopia and the remaining 54 children were emmetropic. Analysis of relative peripheral refraction showed that all the emmetropic and hyperopic children who remained non-myopic at the final visit did not show relative peripheral hyperopia. All children showed myopic shift both centrally and peripherally, however the shift was significant only for myopic children. The myopic children and three out of four that became myopic had a relative peripheral hyperopia at the initial visit which increased further in the final visit. In conclusion, this study shows that children with initial peripheral hyperopia are at risk of developing myopia. However, further studies with larger sample sizes are warranted.

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The importance of sleep, food and physical activity for children and adolescents' health and wellbeing

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Abstract

The past decades have provided great evidence-based knowledge about the importance of lifestyle-factors such as physical activity, nutrition, and sleep for health promotion. Despite this, most teenagers do not adhere to dietary guidelines, and there are concerningly high rates of sleep disturbances and use of sleep medication for this age group. Since 1997, the physical activity level has decreased in young people in general, and among adolescent boys in particular. Since 2010, data on Norwegian young people have also shown increased prevalence of mental health challenges and the use of anti-depressant medication has increased by 53% in 15–18 years old the past decade. On top of this, there is a socioeconomic gradient to the health and wellbeing among children and adolescents. Coming from families with high socioeconomic status makes it more likely that the child or adolescent is more physically active, has healthier nutritional habits, and experiences fewer sleep disturbances.

These trends have led the World Health Organization to define physical inactivity as a global health challenge, and they have aimed to reduce physical inactivity by 15% by 2030. This aim was established prior to the Covid-19 pandemic, and the pandemic seems to have worsened these factors especially among young people. In this keynote, I will present a historical overview of the status of sleep, nutrition and physical activity patterns in children and adolescents, and how these patterns affect their health and wellbeing. Further, I will talk about the knowledge of how these patterns relate to eye health, and what future research should focus on in this area.

A longitudinal study of structural and functional changes in central retina of healthy children

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Abstract

Optical coherence tomography angiography (OCTA) has been extensively used to identify retinal microvasculature anomalies in children either born pre-term or with retinal disorders (Mataftsi et al., 2021; Ong et al., 2020; Tiryaki Denur et al., 2020; Vinekar et al., 2016). However, there is currently a lack of longitudinal data on healthy children born full-term. Moreover, the majority of previous studies in children (Ghassemi et al., 2021; Gołębiewska et al., 2017; Guemes-Villahoz et al., 2021) have used inaccurately scaled images to measure OCTA characteristics resulting in erroneous interpretation. OCTA assumes a standard axial length (AL) for characterising retinal microvasculature. Therefore, it is important to correct the image based on the actual axial length of the child to avoid scaling errors.

Data will be presented from a longitudinal study on characterisation of changes in functional and structural components of the central retina in healthy children given by OCTA. The right eyes of 75 children (44 females) born at full-term were followed up for 12 months. Axial length (AL) was obtained with IOLMaster 500. OCTA images were acquired with a Cirrus 5000HD-OCT at both visits. Images were corrected for lateral magnification errors using ImageJ/Fiji software to give accurate measures of vessel density (VD) and perfusion. Foveal and macular thickness measurements were performed manually. Foveal thickness divided by macular thickness gave the fovea-to-macula thickness ratio (FMTR).

Over time, microvascular characteristics such as VD and perfusion decreased, but structural characteristics such as foveal thickness increased. All children showed a significant decrease in VD and perfusion between visits. We observed that older children showed a faster reduction in microvascular characteristics compared to younger children. There was a significant increase in foveal thickness and a decrease in FMTR for all children over time. We found that older children showed a faster increase in foveal thickness and a faster decrease in FMTR compared to younger children.

Our results show that foveal and macular development is an ongoing process in healthy eyes of healthy children.

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Effect of executive function task performance in augmented reality on accommodation response in young adults: Preliminary findings

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Abstract

Mixed reality (MR) head mounted devices (HMD) are an emerging technology that is becoming common in education and training, healthcare, and engineering. However, there is a concern that the vergence-accommodation conflict (VAC) that is inherent in current HMDs may affect individuals' oculo-motor function. We therefore investigated dynamic vergence and accommodation responses in young adults before and after they performed an executive function task in MR.

Dynamic accommodation and vergence response, DAVR [in dioptres, D], were recorded using the PowerRef 3 photorefractor (Plusoptix GmbH, Nuremberg, Germany) in 20 participants (9 females), age 20–24 years with habitual correction, following a 30 min executive function task (Tower of London) in an MR head-mounted 3D display (HoloLens 2). The task involved arranging virtual objects at 50 cm distance to match patterns presented on a physical 2D screen at 4 m. DAVR was measured over a 1 min period before and after performing the task while participants viewed two targets binocularly at 40 cm (near) and 4 m (distance), alternating between them at 3 sec intervals. The participants were instructed to keep the targets fused and focused. Participants were classified into refractive groups according to their spherical equivalent (SER) cycloplegic refraction (hyperopes: SER $\geq$ +0.50 D, emmetropes: $-0.50 <$ SER $< +0.50$ D and myopes: SER ≤ -0.50 D). DAVR were analysed using paired *t*-test and presented as mean $\pm$ *SD*.

Hyperopes ($n = 5$) exhibited a significant difference in vergence at near (before: 2.57 ± 0.95 D, after: 2.88 ± 1.22 D, $p < 0.001$) and distance (before: 0.35 ± 0.57 D, after: 0.86 ± 0.99 D, $p < 0.001$), and accommodation at near (before: 0.93 ± 0.46 D, after: 2.88 ± 1.22 D, $p < 0.001$) and distance (before: -0.58 ± 0.68 D, after: -0.61 ± 0.65 D, $p < 0.001$). Emmetropes ($n = 11$) also presented a significant difference in vergence at near (before: 2.42 ± 0.69 D, after: 2.77 ± 0.65 D, $p < 0.001$) and distance (before: 0.31 ± 0.55 D, after: 0.82 ± 0.81 D, $p < 0.001$), and accommodation at near (before: 1.28 ± 0.78 D, after: 2.77 ± 0.64 D, $p < 0.001$), but not distance (before: -0.27 ± 0.78 D, after: -0.38 ± 0.77 D, $p = 0.10$). Myopes ($n = 4$) exhibited a significant difference in vergence at near (before: 2.19 ± 0.728 D, after: 2.12 ± 0.77 D, $p = 0.046$), but not distance (before: 0.41 ± 0.65 D, after: 0.41 ± 0.49 D, $p = 0.701$), and accommodation at near (before: 1.26 ± 0.38 D, after: 2.12 ± 0.77 D, $p > 0.001$), but not distance

(before: -0.11 ± 0.77 D, after: -0.23 ± 0.85 D, $p = 0.11$).

All participants were affected by the MR task at near and distance, except for the myopes who appeared to be unaffected at distance (when the accommodation and vergence demands were lower). There were large between-individual differences in DAVR. We speculate that long-term use of MR at near could be detrimental to all individuals, but that it could potentially affect hyperopes to a larger extent than myopes.

Person-centred communication — how does it work?

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Abstract

Person-centred communication promotes person-centred care. Person-centred communication is characterised by trusting relationships, meeting the patient with respect, recognition and sensitivity, responding to the patient's emotions, and managing uncertainty, sharing information, and uncovering the patient's perspective, agreeing on solutions following the patient's values and including patients in choices at the level they want. Listening is essential in person-centred communication.

The traditional Chinese character for listening is made up of several characters, the elements of and requirements for listening: The ear or to hear; we use our ears to listen and understand by listening to the words said and the tone, pace, and emphasis of the words. The eye or to see; we use our eyes to observe body language and pay attention. In that way, we build relationships by listening and assuring others that we are paying attention. The king or to think; we evaluate the words and ideas shared and can be open-minded to what is said or be more critical or analytical when we listen. Therefore, thinking is an essential part of the way we listen. The heart or to feel; we listen with the heart in addition to ears and eyes. When listening with the heart, we experience the emotions shared and feel compassion by listening and relating rationally and emotionally to the person speaking. The number one represents the need for undivided attention and focuses when listening, to listen with individual attention or to be present. To listen effectively, we must reduce unnecessary chatter and focus our attention.

For the clinician, mindfulness and empathy are central in tailoring communication to empower the patient by shared decision-making and supporting and strengthening patient self-efficacy. Mindfulness informs all types of professionally relevant knowledge, both formal knowledge and knowledge learned during practice and observation. Empathic communication encourages trust and mutual understanding. The optometrists' communication self-efficacy relates to personal attributes of mindfulness and empathy (Sundling et al., 2016). Self-efficacy describes a person's belief that they can succeed, and the strength of confidence in success is likely to affect whether people try to achieve the results. Person-centred communication is essential to elicit the patient's needs in decision-making, and providing advice on treatment and involving patients in decisions is a natural part of optometric practice (Sundling et al., 2019). The impact of person-centred communication is better patient satisfaction and better healthcare quality.

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Age-related normal limits for spatial vision in different light conditions

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Abstract

It is well known that visual performance is dependent on illuminance levels. In occupational settings and in the early detection of retinal disease, vision in different light conditions may be of importance. In this study, normal limits of monocular and binocular spatial vision under photopic and mesopic conditions were established.

Photopic and mesopic Visual Acuity (VA) and Functional Contrast Sensitivity (FCS) were measured with both positive and negative contrast optotypes under binocular and monocular viewing conditions using the Acuity-Plus (AP) test. New filters were developed and applied to include participants (age-range 10 to 86 years) who met normal sight criteria. Mean and $\pm 2.5\sigma$ limits were calculated within each 5-year subgroup. Mean values and upper and lower threshold limits for VA and FCS as a function of age were predicted by a biologically meaningful model. The best-fit model parameters describe normal aging of spatial vision for each of the 16 experimental conditions investigated.

Of the 382 participants, 285 passed the selection criteria for normal aging, and enrolled in the analyses to establish normal ageing. Log transforms were applied to ensure approximate normal distributions. Outliers were also removed for each of the 16 stimulus conditions investigated based on the $\pm 2.5\sigma$ limits criterion. Both VA and FCS thresholds were significantly better in photopic conditions when compared to the high mesopic conditions. VA, FCS and the overall variability were found to be age-invariant up to ≈ 50 years in the photopic condition. A lower, age-invariant limit of ≈ 30 years was more appropriate for the mesopic range with a gradual but accelerating increase in both mean thresholds and inter-subject variability above this age. Binocular thresholds were smaller and much less variable when compared to the thresholds measured in either eye. Results with negative contrast optotypes were significantly better than the corresponding results measured with positive contrast ($p < 0.004$).

In line with expectations visual performance was significantly better in higher illuminance levels when compared to lower illuminance levels. Age limits for spatial vision for monocular and binocular viewing under photopic and high mesopic lighting with both positive and negative contrast optotypes were established using a single test which can be implemented either in the clinic or in an occupational setting.

Corneal markers of Diabetic Peripheral Neuropathy

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Abstract

Diabetic peripheral neuropathy or distal polyneuropathy (DPN) is the most common form of diabetic neuropathy (Pasnoor et al., 2013). Half of all patients with diabetes mellitus (DM) suffer from DPN (Stino & Smith, 2017) and early symptoms are tingling or decreased feeling in their toes. DPN can impact balance, posture, gait, and sensation, reduce sleep quality, lead to depression and in late stages foot amputation (Argoff et al., 2006; Domínguez-Muñoz et al., 2020; I. Pearce et al., 2019). The diagnosis of DPN is often made late because screening evaluates large, myelinated nerve fibres which are affected in established neuropathy, rather than detecting small fibre neuropathy (Perkins et al., 2018).

The small nerve fibres are the earliest to be affected by DM, and can both degenerate and regenerate, and they are central in pain and foot ulceration development (Alam et al., 2017). The gold standard for diagnosis of small fibre neuropathy is assessment of intra-epidermal nerve fibres (IENF) by skin biopsy, which is invasive and has a small, but significant risk of bleeding and infection (Alam et al., 2017). The cornea is the most highly innervated tissue in the body (Al-Aqaba et al., 2019) and pathology in corneal nerve fibres seems to manifest before peripheral neuropathy (Stem et al., 2014).

In vivo corneal confocal microscopy (IVCCM) is a rapid non-invasive technique that can directly visualise the corneal nerve fibres in the sub-basal nerve plexus using 2D scans at a resolution of 1–2 μm (Jalbert et al., 2003). The corneal nerve fibre length (CNFL) measured as mm/mm^2, corneal nerve fibre density (CNFD) no/mm^2, and corneal nerve branch density (CNBD) no/mm^2 is reduced in patients with DPN and people with DM without DPN (Jiang et al., 2016). A meta-analysis by Jiang and co-workers suggests that IVCCM is valuable in detecting and assessing early nerve damage (Jiang et al., 2016). Moreover, Petropoulos and co-workers conclude that there is substantial evidence that corneal nerve loss predicts incident neuropathy and progresses with the severity of DPN. There are sufficient diagnostic and prospective validation studies to prove that IVCCM can be used as a biomarker and primary end point in clinical trials of disease-modifying therapies in diabetic neuropathy (Petropoulos et al., 2021).

However, IVCM has a small field of view (400×400 μm), only approximately 0.2% of the entire sub-basal nerve plexus, favouring higher resolution and magnification. The small field of view, the image acquisition area when sampling, quality of the images, and image analysis methods, all introduce biases to the sampling methodology. Further, the time required to analyse the images needs to be shortened before the instrument is efficient in clinical practice (Herrera-Pereda et al., 2021).

In my PhD research I am exploring corneal morphology with the use of IVCCM, corneal sensitivity and markers in tears in people with type 2 diabetes mellitus without diabetic retinopathy and DPN, and in people with evaporative dry eye disease.

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Exploring the Effects of Second-Eye Cataract Surgery on Heading Perception

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Abstract

To effectively navigate and explore our chaotic environment requires an accurate sense of the direction in which we are travelling, known as heading perception. Whilst there is evidence that second-eye cataract surgery (SES) improves performance on tasks requiring heading perception i.e., driving and self-locomotion, the effect of SES on heading perception has not been tested explicitly. SES refers to the removal of an individual's second cataract having previously had the first of two (bilateral) cataracts removed. To test this, participants ($N = 60$) completed

a heading perception task across two visual conditions simulating the effects of SES: monocular blur and no blur. Heading perception was assessed by showing the participants short videos of a moving ground plane. The participants were required to indicate the point on the horizon towards which they were heading. The contrast of the ground plane was manipulated between videos with three levels: low, medium and high. A significant interaction effect was found, indicating that the difference in error between the visual conditions was largest with the low contrast ground plane. These results support the consensus that SES improves night-time driving (when contrast is low) but has a lesser effect on daytime driving (when contrast is high).

Vision competence is lacking in stroke care

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Abstract

Visual impairments (VIs) affect 60% of all stroke survivors, and include reduced visual acuity, eye movement disorders, visual field defects and different perceptual deficits. Post-stroke VIs lead to negative consequences for the stroke survivor and affect the recovery process. Stroke care is generally highly interdisciplinary, but often lacks vision specialists as part of the team. In order to provide better care and follow up of post-stroke VIs the interdisciplinary stroke team needs to integrate vision competence and routines into their practise. As part of the KROSS (Competence and Rehabilitation of Sight after Stroke) Knowledge Translation (KT) project, we aimed to increase the competence and awareness of post-stroke VIs among interdisciplinary health care professionals (HCP) in stroke care (Mathisen, Eilertsen, Ormstad, & Falkenberg, 2021; Mathisen et al., 2022a).

Two qualitative studies in the KROSS KT project explored interdisciplinary HCP perceptions of their competence in vision and how they assessed their patient's visual function. The first included individual interviews with 11 health professionals and managers, and data from two workshop discussions with 26 participants. The interviews were conducted as a part of the preparation process in the KROSS KT project before the implementation started. The second study consisted of four focus group interviews with HCP after the implementation and included their experiences of participating in the KROSS KT project.

Interdisciplinary HCP such as, nurses, physiotherapists and occupational therapists experienced their formal knowledge about the visual function as low. They recalled only briefly learning about eyes and vision during their professional education. Later, in their professional life, problems with vision and visual health were managed by vision experts outside the service they worked in. They had not further developed their theoretical knowledge or clinical skills in vision care and assessment as part of their continuing professional education. This resulted in a lack of both language and terminology to understand reports from vision experts, and they struggled to translate the results from the vision assessment into its practical consequences for their patients. They did, however have some impressions of their patients' visual functions related to other clinical assessments such as cognitive function and balance. Getting access to, and training in using a screening tool such as the KROSS tool helped the participants to assess the visual function after stroke, and they became more confident in performing simple visual tests. Gaining basic knowledge and skills made the participants more aware of the significance and importance of vision in stroke rehabilitation, and they became motivated to further develop their vision competence

Theoretical knowledge of the visual function and clinical skills in assessing vision is lacking among interdisciplinary HCP in municipal health care services. This risks VIs remaining undetected in stroke survivors and other patients that receive health care services, reducing quality of life and the effect of rehabilitation and care. Vision competence needs to be integrated in the education of all HCP in order to improve vision health and promote interdisciplinary collaboration between vision experts and other HCP.

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NorVIS 1st Young Researchers Conference 2022: Abstracts

The first NorVIS Young researchers conference was held at the University of South-Eastern Norway (USN) in Kongsberg on November 16–18, 2022. The aim of the conference is to be an arena for young researchers (in career, not necessarily in age) to share knowledge, get to know each other and stimulate to more research within vision in stroke or other brain injury. The interdisciplinary meeting was organised as a one-day meeting, with presentations including study protocols, master's project, PhD and post doctural clinical research. The meeting was organised by Torgeir S. Mathisen and Helle K. Falkenberg from USN, who also served in the scientific committee together with António F. Macedo (Linnaeus University) and Mirjam van Tilborg (Hogeschool Utrecht). The abstracts from contributing authors are listed in order of presentation.

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"Look for vision after stroke" — A survey of visual assessment practice in Norwegian stroke units

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Abstract

In Norway 12000 people suffer from stroke each year (Helsedirektoratet, 2017), and more than 60% experience visual impairments (VIs). VIs affect quality of life and daily activities but receive little attention in stroke care (Falkenberg et al., 2020; Rowe, 2017; Smith et al., 2018). To identify VIs, it is necessary to implement structured visual assessment. The national clinical guidelines for treatment and rehabilitation in stroke state that visual function should be assessed after stroke, and people with VIs should be referred to an eye care specialist (Helsedirektoratet, 2017). The aim of this project was to describe current practise of visual assessment in Norwegian stroke units (SUs) and compare practice in SUs with and without access to an eye department.

A digital anonymous survey was developed and sent out to all 50 Norwegian SUs. A total of 36 SUs responded, 18 SUs with an eye department (SU1) and 18 SUs without (SU2). All the responding units were included in the analysis. The survey had 28 questions related to routines, organisation, competence and documentation of visual assessment and follow-up. A 5-point rating was used to scale levels of agreement. Free-text answers were analysed with a simple content analysis.

Only half of the SUs performed a routine vision assessment in all in-patients with stroke. This was performed whether VIs were suspected or not. More than two health care professionals were involved in the vision assessment in twenty of the SUs, and this was more common in SUs with eye departments. A systematic vision assessment tool was used in 17 SUs, and VIs were often detected in connection with other examinations in the SU. 24 of the respondents reported to have no formal vision competence. Respondents from units with an eye department underestimated the incidence of visual assessment after stroke and had significantly poorer knowledge than units without an eye department ($p = 0.049$). Lack of understandable language and terminology was a barrier for documenting the visual assessment (mean 3.9, SD = 1.1), and free text answers revealed the ophthalmologists' documentation as difficult to understand.

The results showed that routines for visual assessment in Norwegian SUs were unstructured and unclear, and health care personnel lack competence related to VIs and vision assessment. This study supports that there is a need for structured routines and improved competence about vision in stroke, as well as increased knowledge in vision related terminology that can contribute to better documentation and communication. Future research should investigate what effect a structured vision assessment has on the patient's rehabilitation process and quality of life.

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What is important and meaningful in daily life with visual impairments after stroke — using photovoice to hear the stories from stroke survivors

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Abstract

Vision is important in daily activities and for general rehabilitation after stroke. Visual impairments (VIs) are present in 6 of 10 stroke survivors, however, post-stroke vision rehabilitation lacks structure and is fragmented in Norway. VIs affect performance of vision related tasks such as reading and watching TV, interpreting facial expressions and also social participation and mobility. To promote person-centred vision rehabilitation, it is important to gain in-depth insight into how stroke survivors experience living with VIs. Specifically, how VIs affect everyday life and participation in meaningful activities. This study aimed to explore what stroke survivors with VIs experience as meaningful in their daily life.

The study combined qualitative design with focus group interviews and photovoice method. Stroke survivors with VIs were asked to take digital photographs of what they considered "meaningful in daily life" over a period of two weeks and choose five photos to present for common discussion in a focus group interview. The interviews were recorded and transcribed verbatim.

Preliminary data from one of three focus group interviews revealed that the participants emphasised the importance of cor-

rect training to improve own health and participation in social activities. Visual field loss leads to navigation challenges in both traffic and nature. The ability to continue walks in nature were experienced as a successful vision rehabilitation intervention, which they could practice on their own or with their partner. This despite tripping, falling, getting lost in the woods due to lack of observing deviation of paths and also having to asking for help. Asking for help was also a strategy that aided activities such as going to the shop on their own. Learning to acknowledge that some important activities were difficult, but could still be performed in a new way, was important to them and was considered meaningful.

The preliminary results show that photovoice can be a valuable methodology to explore meaningful daily activities in stroke survivors with VIs. Further, they show that participants with VIs can co-create meaningful new perspectives of living with VIs, which can provide insight on how to promote more person-centred post-stroke vision rehabilitation.

Screening for vision problems in neurorehabilitation: development of a Nordic survey

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Abstract
Vision problems occur frequently after acquired brain injury and have been listed among the top ten priorities that need to be addressed in both clinical practice and research (Pollock et al., 2012; Roberts et al., 2016). However, clinical guidelines in neurorehabilitation provide little direction on how to manage visual problems. The aim of this study was to describe the development of a digital survey in two Nordic countries (Norway and Denmark) designed to investigate clinical practice of vision screening in neurorehabilitation.

A digital survey containing 22 items was developed in Norwegian and Danish by the interdisciplinary project group. The items were selected based on review of literature, clinical experience, meetings in the interdisciplinary Nordic Network on Neurorehabilitation (nordisk-netvaerk-neurorehab.com) and consultation with two researchers who completed similar studies in Great Britain. Three general topics are addressed including clinical practice (e.g., routines on ward and outpatient patient screening, cooperation, and procedures), methods used, and barriers for vision screening and rehabilitation.

Pilot data from interdisciplinary health care professionals showed that the digital platform was suitable for collecting this type of data, and that the time spent was reasonable. However, there were some overlapping questions and grammatical phrases that need to be incorporated in the final survey. It also became clear that there were some cultural differences between the two countries.

Preliminary data from the development and piloting of the survey showed that the topics are relevant and of interest to clinical practice. The final survey will be enrolled by the end of 2022 and data collection will continue during the first months of 2023. It is expected that the survey will provide knowledge on routines and identify what is needed to establish guidelines. Moreover, it will contribute to increase focus and interest in vision rehabilitation and interdisciplinary cooperation to serve as a starting point for more specific and goal-oriented vision rehabilitation in the participating countries

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Testing the diagnosis of visual field loss with a novel VR visual field test after stroke: a study protocol

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Abstract
Many stroke patients suffer visual impairments like blurred vision, double vision, visual field loss, visual neglect and reading difficulties. In stroke units, many patients are bedridden, and fatigue is common. Testing and diagnosing visual function after stroke can be challenging, due to multiple impairments and lack of appropriate tools. Consequently, visual field defects go undetected in a number of patients. Moreover, because patients often are not aware of their visual field loss, there is a risk that rehabilitation is limited or delayed in patients with impairments that have been referred to as "invisible" impairments (Falkenberg et al., 2020; Tharaldsen et al., 2020). Activity avoidance is a common response that has consequences both for quality of life and rehabilitation (Hepworth et al., 2021). Virtual reality (VR) offers flexible visual field testing, and the aim of this project is to assess a novel VR-test for diagnosing visual field defects after stroke.

This pilot study will examine if the VR-test can diagnose visual field defects after stroke, and how it compares to standard visual field confrontation tests and gold standard automated perimetry (SAP). We will recruit 20 adult stroke patients with (n = 12) and without (n = 8) visual field loss. The primary outcome will be identification of visual field loss compared to the standard visual field protocol and the SAP. The VR-test allows for the patient to sit or lie down comfortably, and test time will be another outcome. Patient and user experience will also be evaluated.

The pilot data will be used to adjust the VR-test as necessary and investigate diagnosis of visual field loss in a clinical stroke unit setting (n = 100). Based on the results we will investigate the efficiency and safety of continued use of the VR-test. We hypothesise that the VR-test will improve the diagnosis of visual field defects, contribute to more efficient rehabilitation and better quality of life after stroke.

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StrokeVis: The Oslo study of visual impairment after Stroke

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Abstract

Vision is the most complex sense in humans, with a multifaceted interaction between the eyes and the brain. Studies have shown that up to 60% of patients have some form of new visual impairment after stroke (Rowe et al., 2019). In Norway alone, it is estimated that approximately 30,000 people live with some form of visual impairment following a stroke.

In the annual report of the Norwegian Stroke Register from 2021, only 16% of stroke patients were registered with visual impairment. This figure is significantly lower than expected and indicates a significant under-reporting and/or under-diagnosis.

The Oslo study of visual impairment (StrokeVIS) intends to measure the prevalence of visual impairment after stroke, validate a Norwegian version of the VISA screening tool (Rowe et al., 2020) and compare vision outcomes of acute stroke patients. All acute stroke patients over 18 admitted to the Regional Cerebrovascular Unit at Oslo University hospital with a National Institute of Health Stroke Scale (NIHSS) score < 20 are to be included.

Recruited patients will initially be examined by an orthoptist. This expert examination will function as the prevalence as well as a comparable "Gold-standard". Within 24 hrs the Vision Impairment Screening Assessment (VISA) tool will be administered by a nurse. The nurse will have undergone training in use of the tool but is otherwise untrained in vision diagnostics. All patients will attend a 90-day follow-up with assessments by the orthoptist, including perimetry, and clinical neurological assessments by the neurologist (NIHSS, Montreal Cognitive Assessment (MoCA) and modified Rankin Scale score).

So far, 52 patients have been included. Recruitment is still ongoing at Oslo University Hospital with a completion date of October 2023. Preliminary findings already show feasibility for the use of VISA as a screening tool.

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Implementing competence and routines for structured vision assessment after stroke in municipal health services

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Abstract

Sixty percent of all stroke survivors experience vision problems post stroke. This may lead to reduced quality of life, reduced participation in work and leisure activities and a reduced effect of general stroke rehabilitation. Vision problems after a stroke can be difficult to identify, both for the patient and for healthcare professionals. To identify a visual impairment, the visual function needs to be assessed. The vision assessment tool "Competence on rehabilitation of sight after stroke" (KROSS), previously developed for use in specialist health services, was adapted to a municipal context. The aim of this implementation project was to implement structured vision assessment after stroke using the KROSS tool and improve vision competence within the interdisciplinary stroke team.

The implementation was planned using the "Knowledge to Action" model by Graham et al. (2006) and had a collaborative approach involving partners from the municipal health care services, user organisations and the university's research group. We designed a training programme to improve vision competence among the interdisciplinary stroke team. As part of the project the gap between knowledge and practice, barriers and facilitators to the implementation, and evaluation of the implementation were explored through three qualitative studies (Falkenberg et al., 2020; Mathisen, Eilertsen, Ormstad, & Falkenberg, 2021; Mathisen et al., 2022b).

Stroke survivors experienced that their vision problems received little attention and follow-up in the health services, in contrast to other consequence of their stroke. Municipal health care personnel described a lack of knowledge about vision and skills in assessment of visual function. Although to some extent they observed the patient's vision while doing other assessments such as physical and cognitive function, they lacked tools and knowledge to interpret the observations. By taking part in the training programme, the participants developed theoretical and practical competence in vision assessment using the KROSS tool. The participants experienced that early vision assessment was important for their work with other rehabilitation interventions, as it made it easier to distinguish between visual, cognitive, or motor problems.

Early assessment of visual function after stroke is useful and possible to perform in interdisciplinary municipal health services using the KROSS tool. Further, participation in the implementation led to increased competence and awareness of the importance of vision for general rehabilitation and everyday life. This supports the theory that assessing vision should be integrated into municipal stroke care and included in educational programs of health care personnel.

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