OCULAR HEALTH IN RADIOLOGISTS: A COMPREHENSIVE STUDY EVALUATING COMPUTER VISION SYNDROME AMONGST SOUTH AFRICAN RADIOLOGISTS

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Medicine.

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Declaration

I, Megan van Gensen, declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Medicine at the University of Witwatersrand, Johannesburg. It has not been submitted for any degree at any other university.

Signature:

On this 8th day of July 2025, in Johannesburg

Abstract:

Ocular health in radiologists: A comprehensive study evaluating computer vision syndrome amongst South African radiologists.

Background

Computer vision syndrome is a common problem amongst regular computer users. With a large portion of workflow in radiology making use of Picture Archiving and Communicating Systems (PACS), radiologists are at risk for exposure to potential ocular hazards.

Objectives

The aim of this study was to determine the prevalence of computer vision syndrome amongst South African radiologists as well as raise awareness of the matter and propose implementable solutions.

Methods

An electronic cross-sectional observational study of South African radiologists using a self-administered survey, was conducted from January 2025 to February 2025.

Results

207 complete responses were received with a response rate of 19.4%. The prevalence of a high computer vision syndrome (CVS) score (>6) was 63% (95% CI 56% - 69%). There was a higher proportion of females among those with a high CVS score compared to those with a low CVS score (60% vs 39%, $p = 0.004$). Eyewear was common, with only 28% of the group with a high CVS score not making use of them. The most common symptoms of CVS in this cohort were headache (63%), sensitivity to light (60%), worsening vision (57%), dryness (54%) and burning (56%). The least common symptoms of CVS in this cohort were double vision (12%) and coloured haloes (18%). The mean score in those without CVS was 2, while the mean score in those with CVS was 16. Factors found to be associated with having a high CVS score on multivariate analysis were subspecialists in musculoskeletal ($p = 0.015$), respondents who wear predominantly spectacles (no blue light filter) ($p = 0.013$), respondents who use eye drops ($p < 0.001$) and those respondents who had worsened eyesight ($p < 0.001$).

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List of tables:

1. Introduction:

Computer vision syndrome (CVS) is defined by the American Optometric Association as a "group of eye and vision related problems that result from prolonged computer, tablet, e-reader and cell phone use." (1) These symptoms include eye strain and tired, painful eyes;(2) dry eyes, foreign body sensation or grittiness and burning of the eye, (2–4)diplopia, blurry vision, difficulty in focus and headaches;(2) as well as, extra-ocular complaints, including musculoskeletal symptoms such as back, neck and shoulder pain.(3,5–7)

Practicing diagnostic radiology, exposes doctors to a unique subset of occupational hazards in addition to exposure to ionizing radiation.(8,9) The shift toward making use of visual display units (VDUs) with a large portion of the radiologists' workflow on Picture Archiving Systems (PACS), raises concerns about ocular hazards.(7,8,10) In a profession that relies heavily on eyesight, ocular health is paramount to a productive career.

Computer vision syndrome has been extensively studied in regular computer users, such that in 1990 legislation was enacted in Europe regarding the occupational use of computers labelled Directive 90/270/EEC.(9) This legislation places the onus on employers to inform their employees of the health and safety risks when using computers and to ensure that regular breaks are implemented. It is also a requirement that employees undergo regular eye tests.(9) While legislation in Europe has addressed computer-related occupational hazards(9), similar studies and regulations are lacking in South Africa. CVS is unlikely to result in permanent ocular damage, however, it may be bothersome especially towards the end of a long shift(2,3) and thus diagnostic accuracy may be negatively affected.(3)

CVS is emerging as a concern among South African radiologists, with potential implications for their work and health. This study was therefore done to investigate CVS symptoms amongst South African radiologists. To our knowledge this is the first study to investigate CVS symptoms in this cohort.

2. Methods:

A cross-sectional observational study of South African radiologists using a self-administered survey was conducted from January 2025 to February 2025. This study was approved by the Human Research Ethics Committee of the University of the Witwatersrand (certificate number M240720).

Permission was granted by Dr Richard Tuft, Executive Director (at the time of writing) of the Radiological Society of South Africa (RSSA), to distribute an electronic survey to its members. Active members at the time of writing and data collection totalled 1074 radiologists.(11)

The email sent out to members included a participation information sheet. No sampling was performed, and all eligible doctors were invited to participate in the survey – this included radiology consultants (attendings) registered to practice within South Africa, both in the state and private sector as well as radiologists in training, which include both registrars (residents) and medical officers. Radiologists no longer in practice were excluded from participating in the survey.

The survey consisted of two parts. The first part collected demographic information pertaining to age, self-reported ethnicity, sex, rank, number of years in practice, as well as radiological field of practice. Participants were asked questions regarding working hours, frequency of breaks during the workday, use of spectacles or contact lenses, and use of eye drops as lubricant.

The second part of the survey consisted of a validated CVS Questionnaire, published by Del Mar Segui, *et al*.,(12) which collected data regarding specific ocular symptoms as well as their frequency and severity. Permission was gained through Bibliopro for use of this validated questionnaire.

The survey was conducted using the RedCap platform, hosted by the University of the Witwatersrand. RedCap was used due to its secure data collection and storage.(13,14) To maintain anonymity, no identifying features, including email addresses, were collected.

Submission of the survey was disallowed unless completed in full – this prevented incomplete data being collected. The response rate totaled 219 during the collection period of two months. An initial email was sent out with request for completion, with two reminders for completion prior to closure of the survey.

Scoring of tests was done as per *Seguí Mdel M, Cabrero-García J, Crespo A, Verdú J, Ronda E. A reliable and valid questionnaire was developed to measure computer vision syndrome (CVS) at the workplace.(12)*

Any observation with missing demographic variables was excluded from the analysis as the sample size is large enough to not be affected by this. We compared demographic and behavioural factors by those who had a calculated CVS score of <6 and ≥6.

A linear regression model was applied to each variable (univariable regression) and to all variables (multivariable regression) to determine the effect of factors on the log of the CVS score. The tables presented show the exponentiated beta from the log transformation and should be interpreted as a factor increase or decrease in the mean CVS score. Thereafter, a general linear model was used to determine factors associated with having a high (≥6) CVS score as an Odds Ratio (OR).

3. Results:

All surveys were assessed for completeness, and surveys with missing demographic data were excluded from the study. A total of 219 responses were recorded on RedCap, with a total of 207 responses after exclusions. The electronically distributed survey reached a total number of 1074 radiologists, with a response rate of 19,2%. The response rate of eligible participants is unknown, as the membership includes retired radiologists, who were excluded from participation.

3.1. Demographics:

The prevalence of a high (≥6) CVS score among radiologists was 63% (95% CI 56%-69%) (see Table 1). There was a higher proportion of females among those with a high CVS score compared to those with a low CVS score (60% vs 39% p-value 0.004).

Table 1: Prevalence of computer vision syndrome (CVS) in South African radiologists

Characteristic	N = 207[1]	95% CI
CVS score >6		
<6	77 (37%)	31%, 44%
≥6	130 (63%)	56%, 69%
Total score	8 (4, 15)	9.5, 12

[1]n (%); Median (Q1, Q3)
Abbreviation: CI = Confidence Interval

Radiologists aged 30-45 made up the largest of the sample population, however when looking at the logistic regression, age was not found to be statistically significant when comparing the age groups with the under 30s as the reference group.

Of the respondents with high CVS scores: 46% were white, 32% were black, 4.6% were coloured, 16% Asian/Indian, and 0.8% other, and there was no evidence that these proportions differed among those with low CVS scores.

The majority of respondents identified themselves as general radiologists and 87% of those who had a CVS score of ≥6 reported working in the field of general radiology. On multivariable analysis of the logistic regression, radiologists who reported working predominantly in mammography had a 33% lower odds (aOR of 0.67, p = 0.02) of having high CVS, and those working predominantly in musculoskeletal subspecialities had 32% lower odds (aOR of 0.68, p = 0.015) of having high CVS when compared to the general radiology group. There were five respondents who were involved in cardiothoracic, and all had a high CVS score however, there was insufficient evidence to demonstrate a difference in this proportion compared to those in general radiology (p-value >0.05).

In terms of level of experience, registrars made up the largest proportion of the group of high CVS scorers at 41%, then senior consultants at 36%, then junior consultants at 21%, and lastly medical officers with a portion of 2.3%. There were no differences in the proportions of rank, between those with low and high CVS scores.

When assessing duration of years in practice: radiologists in practice for 5-10 years had a 24% higher odds of a high CVS score compared to <5 years in practice (OR 1.24, p = 0.015), however these characteristics was not selected for multivariable analysis.

Table 2: Descriptive statistics of the study population CVS questionnaire responses by CVS status (with "missing" not counted and omitted from the table)

Characteristic	**Overall**, N = 207 (100%)[1]	**<6**, N = 77 (37%)[1]	**≥6**, N = 130 (63%)[1]	**p-value**[2]
Burning				<0.001
Never	91 (44%) (37%, 51%)	59 (77%) (65%, 85%)	32 (25%) (18%, 33%)	
Occasionally	87 (42%) (35%, 49%)	18 (23%) (15%, 35%)	69 (53%) (44%, 62%)	
Often or always	29 (14%) (9.7%, 20%)	0 (0%) (0.00%, 5.9%)	29 (22%) (16%, 31%)	
Burning intensity				0.2
Intense	12 (11%) (5.8%, 18%)	0 (0%) (0.00%, 23%)	12 (12%) (6.8%, 21%)	
Moderate	102 (89%) (82%, 94%)	17 (100%) (77%, 100%)	85 (88%) (79%, 93%)	
Itching				<0.001
Never	100 (48%) (41%, 55%)	60 (78%) (67%, 86%)	40 (31%) (23%, 40%)	
Occasionally	87 (42%) (35%, 49%)	17 (22%) (14%, 33%)	70 (54%) (45%, 63%)	
Often or always	20 (9.7%) (6.1%, 15%)	0 (0%) (0.00%, 5.9%)	20 (15%) (9.9%, 23%)	
Itching intensity				0.6
Intense	6 (5.7%) (2.3%, 13%)	0 (0%) (0.00%, 25%)	6 (6.7%) (2.7%, 14%)	
Moderate	99 (94%) (87%, 98%)	15 (100%) (75%, 100%)	84 (93%) (86%, 97%)	
Feeling of foreign body				<0.001
Never	130 (63%) (56%, 69%)	69 (90%) (80%, 95%)	61 (47%) (38%, 56%)	
Occasionally	65 (31%) (25%, 38%)	8 (10%) (4.9%, 20%)	57 (44%) (35%, 53%)	
Often or always	12 (5.8%) (3.2%, 10%)	0 (0%) (0.00%, 5.9%)	12 (9.2%) (5.1%, 16%)	
Feeling of foreign body intensity				>0.9
Intense	5 (6.7%) (2.5%, 16%)	0 (0%) (0.00%, 48%)	5 (7.2%) (2.7%, 17%)	
Moderate	70 (93%) (84%, 98%)	6 (100%) (52%, 100%)	64 (93%) (83%, 97%)	
Tearing				<0.001
Never	111 (54%) (47%, 61%)	62 (81%) (70%, 88%)	49 (38%) (29%, 47%)	
Occasionally	77 (37%) (31%, 44%)	15 (19%) (12%, 30%)	62 (48%) (39%, 57%)	
Often or always	19 (9.2%) (5.8%, 14%)	0 (0%) (0.00%, 5.9%)	19 (15%) (9.3%, 22%)	
Tearing intensity				0.6
Intense	8 (8.8%) (4.1%, 17%)	0 (0%) (0.00%, 30%)	8 (10%) (4.8%, 19%)	
Moderate	83 (91%) (83%, 96%)	12 (100%) (70%, 100%)	71 (90%) (81%, 95%)	
Excessive blinking				<0.001
Never	131 (63%) (56%, 70%)	70 (91%) (82%, 96%)	61 (47%) (38%, 56%)	
Occasionally	55 (27%) (21%, 33%)	6 (7.8%) (3.2%, 17%)	49 (38%) (29%, 47%)	
Often or always	21 (10%) (6.5%, 15%)	1 (1.3%) (0.07%, 8.0%)	20 (15%) (9.9%, 23%)	
Excessive blinking intensity				>0.9
Intense	6 (8.2%) (3.4%, 18%)	0 (0%) (0.00%, 54%)	6 (8.8%) (3.6%, 19%)	
Moderate	67 (92%) (82%, 97%)	5 (100%) (46%, 100%)	62 (91%) (81%, 96%)	

Eye redness				<0.001
Never	116 (56%) (49%, 63%)	69 (90%) (80%, 95%)	47 (36%) (28%, 45%)	
Occasionally	68 (33%) (27%, 40%)	8 (10%) (4.9%, 20%)	60 (46%) (37%, 55%)	
Often or always	23 (11%) (7.3%, 16%)	0 (0%) (0.00%, 5.9%)	23 (18%) (12%, 26%)	
Eye redness intensity				0.6
Intense	11 (12%) (6.6%, 21%)	0 (0%) (0.00%, 40%)	11 (13%) (7.2%, 23%)	
Moderate	79 (88%) (79%, 93%)	8 (100%) (60%, 100%)	71 (87%) (77%, 93%)	
Eye pain				<0.001
Never	124 (60%) (53%, 67%)	70 (91%) (82%, 96%)	54 (42%) (33%, 51%)	
Occasionally	68 (33%) (27%, 40%)	7 (9.1%) (4.0%, 18%)	61 (47%) (38%, 56%)	
Often or always	15 (7.2%) (4.3%, 12%)	0 (0%) (0.00%, 5.9%)	15 (12%) (6.8%, 19%)	
Eye pain intensity				>0.9
Intense	4 (5.4%) (1.7%, 14%)	0 (0%) (0.00%, 69%)	4 (5.6%) (1.8%, 15%)	
Moderate	70 (95%) (86%, 98%)	3 (100%) (31%, 100%)	67 (94%) (85%, 98%)	
Heavy eyelids				<0.001
Never	118 (57%) (50%, 64%)	67 (87%) (77%, 93%)	51 (39%) (31%, 48%)	
Occasionally	68 (33%) (27%, 40%)	9 (12%) (5.8%, 22%)	59 (45%) (37%, 54%)	
Often or always	21 (10%) (6.5%, 15%)	1 (1.3%) (0.07%, 8.0%)	20 (15%) (9.9%, 23%)	
Heavy eyelids intensity				0.6
Intense	10 (12%) (6.2%, 21%)	0 (0%) (0.00%, 37%)	10 (14%) (7.0%, 24%)	
Moderate	73 (88%) (79%, 94%)	9 (100%) (63%, 100%)	64 (86%) (76%, 93%)	
Dryness				<0.001
Never	95 (46%) (39%, 53%)	61 (79%) (68%, 87%)	34 (26%) (19%, 35%)	
Occasionally	68 (33%) (27%, 40%)	16 (21%) (13%, 32%)	52 (40%) (32%, 49%)	
Often or always	44 (21%) (16%, 28%)	0 (0%) (0.00%, 5.9%)	44 (34%) (26%, 43%)	
Dryness intensity				0.002
Intense	34 (31%) (23%, 41%)	0 (0%) (0.00%, 24%)	34 (36%) (27%, 47%)	
Moderate	76 (69%) (59%, 77%)	16 (100%) (76%, 100%)	60 (64%) (53%, 73%)	
Blurred vision				<0.001
Never	110 (53%) (46%, 60%)	65 (84%) (74%, 91%)	45 (35%) (27%, 44%)	
Occasionally	77 (37%) (31%, 44%)	12 (16%) (8.7%, 26%)	65 (50%) (42%, 58%)	
Often or always	20 (9.7%) (6.1%, 15%)	0 (0%) (0.00%, 5.9%)	20 (15%) (9.9%, 23%)	
Blurred vision intensity				0.3
Intense	13 (14%) (8.0%, 23%)	0 (0%) (0.00%, 34%)	13 (16%) (9.0%, 26%)	
Moderate	79 (86%) (77%, 92%)	10 (100%) (66%, 100%)	69 (84%) (74%, 91%)	
Double vision				<0.001
Never	182 (88%) (83%, 92%)	76 (99%) (92%, 100%)	106 (82%) (74%, 88%)	
Occasionally	20 (9.7%) (6.1%, 15%)	1 (1.3%) (0.07%, 8.0%)	19 (15%) (9.3%, 22%)	
Often or always	5 (2.4%) (0.89%, 5.9%)	0 (0%) (0.00%, 5.9%)	5 (3.8%) (1.4%, 9.2%)	
Double vision intensity				>0.9
Intense	4 (16%) (5.3%, 37%)	0 (0%) (0.00%, 95%)	4 (17%) (5.5%, 38%)	

Moderate	21 (84%) (63%, 95%)	1 (100%) (5.5%, 100%)	20 (83%) (62%, 95%)	
Difficulty focusing				<0.001
Never	109 (53%) (46%, 60%)	61 (79%) (68%, 87%)	48 (37%) (29%, 46%)	
Occasionally	64 (31%) (25%, 38%)	12 (16%) (8.7%, 26%)	52 (40%) (32%, 49%)	
Often or always	34 (16%) (12%, 22%)	4 (5.2%) (1.7%, 13%)	30 (23%) (16%, 31%)	
Difficulty focusing intensity				0.037
Intense	20 (21%) (13%, 31%)	0 (0%) (0.00%, 27%)	20 (24%) (16%, 35%)	
Moderate	76 (79%) (69%, 87%)	14 (100%) (73%, 100%)	62 (76%) (65%, 84%)	
Sensitivity to light				<0.001
Never	83 (40%) (33%, 47%)	51 (66%) (54%, 76%)	32 (25%) (18%, 33%)	
Occasionally	79 (38%) (32%, 45%)	24 (31%) (21%, 43%)	55 (42%) (34%, 51%)	
Often or always	45 (22%) (16%, 28%)	2 (2.6%) (0.45%, 9.9%)	43 (33%) (25%, 42%)	
Sensitivity to light intensity				0.001
Intense	32 (26%) (19%, 35%)	0 (0%) (0.00%, 17%)	32 (33%) (24%, 43%)	
Moderate	90 (74%) (65%, 81%)	24 (100%) (83%, 100%)	66 (67%) (57%, 76%)	
Sight is worsening				<0.001
Never	89 (43%) (36%, 50%)	57 (74%) (63%, 83%)	32 (25%) (18%, 33%)	
Occasionally	83 (40%) (33%, 47%)	19 (25%) (16%, 36%)	64 (49%) (40%, 58%)	
Often or always	35 (17%) (12%, 23%)	1 (1.3%) (0.07%, 8.0%)	34 (26%) (19%, 35%)	
Sight is worsening intensity				0.002
Intense	35 (30%) (22%, 39%)	0 (0%) (0.00%, 21%)	35 (36%) (27%, 47%)	
Moderate	81 (70%) (61%, 78%)	19 (100%) (79%, 100%)	62 (64%) (53%, 73%)	
Coloured haloes				<0.001
Never	169 (82%) (76%, 87%)	76 (99%) (92%, 100%)	93 (72%) (63%, 79%)	
Occasionally	30 (14%) (10%, 20%)	1 (1.3%) (0.07%, 8.0%)	29 (22%) (16%, 31%)	
Often or always	8 (3.9%) (1.8%, 7.7%)	0 (0%) (0.00%, 5.9%)	8 (6.2%) (2.9%, 12%)	
Coloured haloes intensity				>0.9
Intense	8 (22%) (10%, 39%)	0 (0%) (0.00%, 95%)	8 (22%) (11%, 40%)	
Moderate	29 (78%) (61%, 90%)	1 (100%) (5.5%, 100%)	28 (78%) (60%, 89%)	
Headache				<0.001
Never	76 (37%) (30%, 44%)	53 (69%) (57%, 79%)	23 (18%) (12%, 26%)	
Occasionally	101 (49%) (42%, 56%)	22 (29%) (19%, 40%)	79 (61%) (52%, 69%)	
Often or always	30 (14%) (10%, 20%)	2 (2.6%) (0.45%, 9.9%)	28 (22%) (15%, 30%)	
Headache intensity				0.044
Intense	28 (22%) (15%, 30%)	1 (4.5%) (0.24%, 25%)	27 (25%) (18%, 35%)	
Moderate	100 (78%) (70%, 85%)	21 (95%) (75%, 100%)	79 (75%) (65%, 82%)	

[1]n (%)
[2]Pearson's Chi-squared test; Fisher's exact test
Abbreviation: CI = Confidence Interval

3.2. Symptoms:

Of the group with a high CVS score of ≥6, 28% did not use eyewear, 2.3% predominantly contact lenses, 28% predominantly spectacles (no blue light filter), 10% both contact lenses and spectacles, and 31% blue light filter (either corrective or non-corrective). The group using predominantly spectacles had 24% higher odds of having a high CVS score in comparison to the group with no eyewear (aOR 1.24, p = 0.013). Having any blue light filter compared to those without blue light filters (and no corrective lenses) showed no evidence of an association between different CVS scores or having a high CVS score (p-value 0.7). Those using eye-drops had a higher odds ratio (aOR 1.3 95% CI1.12-1.52 p-value < 0.001) associated with a high CVS score compared to those not using any eye-drops.

Of the portion of high CVS scorers, 7.7% of participants have never had an eye examination by either an optometrist or ophthalmologist, with 73% of participants having an eye examination in the last two years. The remainder of participants, 19%, have not had a recent eye examination, with their last eye examination more than two years ago.

Participants with a high CVS score spend most of their time reviewing images on computers – 54% of participants spend 6-8 hours reviewing images on computers and 38% of participants spending more than 8 hours in front of a computer screen. A very small proportion (6.8%) of high CVS scorers spend more than 8 hours reviewing plain films on light boxes. The majority of participants and those with high CVS scores spend < 4 hours reviewing case on plain films (97% of participants with CVS score of <6 and 92% of participants with a CVS score of ≥6).

Typical workflow behaviour reported by participants was as follows: 57% spend 6-8 hours on a computer, 94% spend <4 hours on film, and 51% take breaks every 1-3 hours. There was no evidence that these proportions differed between those with high and low CVS scores.

Participants were asked questions regarding a range of symptoms experienced including their frequency and intensity. Symptoms included: burning, itching, feeling of foreign body, tearing, excessive blinking, eye redness, eye pain, headache, heavy eyelids, dryness, blurred vision, double vision, difficulty focusing, sensitivity to light, coloured haloes and worsening sight.

When assessing the CVS scores of participants, we grouped them into those with computer vision syndrome i.e. scores of ≥6 and those without computer vision syndrome i.e. those with scores <6.

The most frequently encountered symptoms in those with computer vision syndrome include the following: headache, sensitivity to light, worsening vision, dryness and burning.

Of the participants with computer vision syndrome (see Table 2), 79 (61%) participants occasionally have headaches, and 28 (22%) participants have headaches often or always. 27 (25%) participants report intense headaches, while 79 (75%) participants experience only moderate symptomatology. Only 23 (18%) participants with computer vision syndrome do not experience headache as a symptom. The least frequently encountered symptoms in the population with CVS are double vision and coloured haloes. 106 participants (82 % of participants with computer vision syndrome) reported not having experienced double vision, while 93 participants report never having experienced coloured haloes. Of those who reported having experienced double vision (n=25), 83% report having only moderate intensity. Of those who reported having experienced coloured haloes (n = 37), 78% reported having only moderate intensity.

In participants with computer vision syndrome, the self-reported intensity of all tested symptoms was moderate, with a small percentage of participants reporting severe intensity. When comparing severity of symptoms between those participants with computer vision syndrome and those without computer vision syndrome, all symptomatology is worse in the CVS group. Within the high CVS group, the highest mean score was sensitivity to light (Ssee Table 3), followed by the dryness score, sight score, and headache score. The lowest mean score within the group with a high CVS score was experiencing coloured haloes.
The mean score in those without CVS is 2, while the mean score in those with CVS is 16.

Table 3: Mean CVS score by having high or low CVS score

Characteristic	**<6** N = 80[1]	**≥6** N = 134[1]
Burning score	0.21 (0.41)	1.12 (1.04)
Itching score	0.19 (0.39)	0.93 (0.91)
Foreign body score	0.08 (0.27)	0.68 (0.85)
Tearing score	0.15 (0.36)	0.85 (0.95)
Blinking score	0.08 (0.31)	0.76 (0.90)
Redness score	0.10 (0.30)	0.94 (1.05)
Pain score	0.04 (0.19)	0.70 (0.79)
Eyelids score	0.13 (0.37)	0.86 (1.05)
Dryness score	0.21 (0.41)	1.50 (1.42)
Blurred vision score	0.13 (0.33)	0.96 (1.07)
Double vision score	0.01 (0.11)	0.28 (0.76)
Difficulty focusing score	0.23 (0.53)	1.16 (1.32)
Sensitivity to light score	0.34 (0.53)	1.52 (1.35)
Haloes score	0.01 (0.11)	0.43 (0.85)
Sight score	0.25 (0.46)	1.46 (1.38)
Headache score	0.33 (0.55)	1.40 (1.24)
Total score	2 (2)	16 (9)

[1]Mean (SD)

Table 4: Factors associated with a high CVS score

	Univariable			Multivariable		
Characteristic	**OR**	**95% CI**	**p-value**	**aOR**	**95% CI**	**p-value**
Age						
< 30	—	—				
30 – 45	1.14	0.81, 1.61	0.5			
46 – 60	1.20	0.83, 1.73	0.3			
>60	1.00	0.66, 1.52	>0.9			
Sex						
Male	—	—		—	—	
Female	1.22	1.07, 1.39	0.003	1.12	0.99, 1.27	0.077
Ethnicity						
White	—	—		—	—	
Black	1.03	0.89, 1.19	0.7	0.94	0.82, 1.08	0.4
Coloured	1.52	1.02, 2.25	0.040	1.29	0.90, 1.84	0.2
Indian/Asian	1.22	0.99, 1.49	0.062	1.17	0.97, 1.41	0.11
Other	0.92	0.47, 1.80	0.8	0.74	0.41, 1.33	0.3
Rank						
Medical Officer	—	—				
Registrar	1.12	0.75, 1.66	0.6			
Junior Consultant (< 5years)	1.34	0.88, 2.04	0.2			
Senior Consultant (>5 years)	1.09	0.73, 1.63	0.7			
Years in practice						
< 5 years	—	—				
5 - 10 years	1.24	1.05, 1.48	0.015			
11 - 15 years	1.07	0.87, 1.30	0.5			
16 - 20 years	0.96	0.74, 1.26	0.8			
21 - 30 years	1.09	0.87, 1.36	0.5			
>30 years	0.90	0.68, 1.19	0.5			
Subspecialty						
General Radiology	—	—		—	—	
Interventional Radiology	0.73	0.42, 1.26	0.3	0.80	0.49, 1.30	0.4

	Univariable			Multivariable		
Characteristic	**OR**	**95% CI**	**p-value**	**aOR**	**95% CI**	**p-value**
Neuroradiology	0.80	0.56, 1.15	0.2	0.80	0.58, 1.11	0.2
Paediatric Radiology	1.43	0.83, 2.46	0.2	0.83	0.50, 1.38	0.5
Mammography	0.73	0.50, 1.08	0.12	0.67	0.47, 0.95	0.024
Musculoskeletal	0.76	0.54, 1.07	0.12	0.68	0.50, 0.92	0.015
Cardiothoracic	1.43	0.93, 2.18	0.10	1.36	0.93, 1.99	0.12
Eyewear						
None	—	—		—	—	
Predominantly contact lenses	0.85	0.60, 1.20	0.4	0.82	0.59, 1.14	0.2
Predominantly spectacles (no blue light filter)	1.23	1.03, 1.46	0.022	1.24	1.05, 1.46	0.013
Both spectacles (no blue light filter) and lenses	1.48	1.13, 1.94	0.005	1.17	0.91, 1.51	0.2
Blue light lenses (either corrective or non-corrective)	1.07	0.91, 1.26	0.4	1.08	0.93, 1.25	0.3
Uses spectacles	1.19	1.04, 1.36	0.013			
Uses blue light filter	0.97	0.84, 1.12	0.7			
Eye drops						
No	—	—		—	—	
Yes	1.45	1.25, 1.68	<0.001	1.30	1.12, 1.52	<0.001
Eye examination						
Never	—	—				
In the last year	1.15	0.91, 1.46	0.2			
1 - 2 years	1.06	0.82, 1.36	0.7			
>2 years ago	1.12	0.86, 1.46	0.4			
Hours on computer						
< 4 hours	—	—		—	—	
4-6 hours	1.87	0.70, 4.98	0.2	1.52	0.62, 3.74	0.4
6 - 8 hours	1.91	0.73, 4.98	0.2	1.77	0.74, 4.25	0.2
>8 hours	1.84	0.71, 4.79	0.2	1.51	0.63, 3.62	0.4
Hours on film						
< 4 hours	—	—		—	—	
6 - 8 hours	1.47	0.85, 2.55	0.2	1.36	0.83, 2.23	0.2
> 8 hours	1.21	0.89, 1.64	0.2	1.31	0.98, 1.74	0.065
Breaks						
Every hour	—	—				

	Univariable			Multivariable		
Characteristic	**OR**	**95% CI**	**p-value**	**aOR**	**95% CI**	**p-value**
1-3 hourly	1.05	0.82, 1.34	0.7			
>4 hourly	1.13	0.86, 1.47	0.4			
Never	1.13	0.86, 1.48	0.4			
Worsened eyesight						
Yes	—	—		—	—	
No	0.73	0.64, 0.83	<0.001	0.74	0.66, 0.84	<0.001

Abbreviation: CI = Confidence Interval

4. Discussion:

Studies worldwide have reported a high prevalence of CVS among visual display unit (VDU) users, ranging from 32% to 90%.(2,8) CVS is also common amongst radiologists globally with studies supporting this. Vertinsky *et al.* surveyed a group of North American radiologists and the prevalence of eye strain was 36%.(3) Ayman *et al*. conducted a study in Saudi Arabia which showed a prevalence of CVS of 65.4% among radiologists.(8) The prevalence noted in these studies, in both visual display users and studies conducted in radiologists, is comparable to the prevalence of 63% in South African radiologists. A predilection for females has been shown in other studies,(8,15) which was demonstrated in our study as well. Our descriptive statistics showed that among those with high (≥6) CVS score, 60% was female (p = 0.004). In multivariable analysis however, the odds associated with a high CVS score among females was 1.12 but this was not significant at the 0.05 level (p-value = 0.077) indicating confounding factors associated with sex differences account for having a high CVS score.

CVS is more likely to occur in those who use screens for a long duration.(2,7,9) On multivariable analysis in our study of South African radiologists, those spending more than 8 hours in front of a screen, are 51% more likely to suffer from computer vision syndrome than those spending less than 8 hours, however the p-value was not significant at the 0.05 level (p = 0.065). This may be due to an underestimation of respondents of their actual time if they know spending long time in front of screens may be damaging and have a social desirability to report less time than reality. In radiologists, this long duration in front of a computer for both reporting duties and administrative tasks, as well as the use of smart phones and devices have been shown to significantly increase their risk of CVS.(8)

Environmental factors such as air-conditioning in offices and workspaces were not studied as part of this survey but are known to contribute to symptoms of dry eye. (4,6) Contact lens use worsens dry eye symptoms due to reduced production of tears during wear.(2,6) Corrective lens use is common in South African radiologists, where 63% of respondents made use of corrective lenses, as seen in other studies. A study done in North American radiologists found that the use of corrective lenses was not a predictor for eye strain.(3) The opposite was demonstrated in our

study, where 69% of those with a high CVS score of ≥6 wore spectacles (p=0.013). Making use of blue light filters did not show evidence of an effect in our analyses (p = 0.7).

Among those with high (≥6) CVS score, 19% have not had a recent eye exam (either by an optometrist or an ophthalmologist), and 18% of participants with a low CVS score of <6 have not had a recent eye examination. Person *et al.* have shown that uncorrected refractive error will contribute to the effects of digital eye strain.(16)

In our study we found that radiologists with 5-10 years of experience had 24% higher odds of having a high CVS score in comparison to the <5years of the experience group (p = 0.015). This group is likely comprised of a mixture of senior residents and junior consultants. In a previous study done evaluating radiologists and their risk for CVS; junior radiologists - particularly registrars - were at higher risk for developing CVS in comparison to their senior counterparts. This was attributed to the relative inexperience of junior radiologists who require more time to analyse images, as well as the larger burden of afterhours workload. This predilection for CVS in a younger demographic is unique to radiology, as the reverse is true in the general population where elderly computer users are at higher risk for CVS.(9)

There seems to be some correlation with radiology subspeciality and computer vision syndrome. In a study conducted in North American radiologists, those performing screening CT, whole body CT and CT colonography were at higher risk for eye strain.(3) In our study, on multivariable analysis, there was no group at higher risk for computer vision syndrome. However, we found that those in the subspeciality of mammography and musculoskeletal imaging, had lower odds of having a high CVS score in comparison to the general radiology group. These results, even though statistically significant should be interpreted with caution, as the sample size for both groups was small (mammography n = 6, musculoskeletal n = 8). This is somewhat promising as prevention strategies can be universal across sub-specialties.

When analysing the categorical data with Fisher's exact test and Pearson's Chi-squared test, the following were found to be statistically significant for a high CVS score: female sex, eyewear, use of eyedrops and worsened eyesight. However, on multivariable analyses, only the

following were statistically significant – specific subspecialities, use of spectacles, use of eyedrops and worsened eyesight.

4.1. Limitations:

All cross-sectional, or purely observational studies suffer from an element of selection bias and difficulty to establish causal inference, as those suffering from CVS may be more likely to respond to the survey. Participants were encouraged to complete the survey even if no symptoms were experienced. In some cases, we see reversals in expected findings, for instance, if we assumed that eye-drops are helpful, we would expect those that use eye-drops to have a lower CVS score than those who do not, but instead we note that using eye-drops is associated with a higher CVS score and higher odds of having a score of ≥6. This of course, does not imply that eye-drops cause CVS, but rather that those who have had complaints relating to their eyes were more likely to use eye-drops already. This is a limitation of the study design, in that there are limitations in the inferences. In addition, there may be social desirability to certain question, amplifying or reducing their effect in the analysis.

4.2. Recommendations:

Several strategies have been suggested to alleviate CVS symptoms. These strategies require both personal and institutional implementation. The widely described 20-20-20 strategy has been recommended to lessen the effect of CVS and requires individuals to focus on something 20 feet (6 meters) away every 20 minutes for 20 seconds to allow the eyes to rest.(2,3,6,9) VDUs should be placed below eye level at a distance of 60cm – 100cm(2,3). Regular breaks are also suggested, this will improve both diagnostic accuracy and productivity as the effect of fatigue is lessened. (2,6,8) Correction of refractive errors are important, as uncorrected refractive error can result in an increase in visual demand and further exacerbate fatigue.(2,7,8) Symptoms of dry eye can be alleviated by limiting the use of contact lenses in favour of spectacles,(6) as well as making use of artificial tears.(2,4,9) Use of blue light filtered spectacles has been described,(2) however, there is a lack of robust data to support their usage and they remain a controversial tool in the prevention of visual strain.(5,17)

Endorsement from the institution in combating CVS is equally as important as the personal implementation strategies listed above. These strategies include optimisation of workspace

ergonomics for the individual,(2,3,7) regular inspection of the luminance of monitors,(2) placement of anti-glare filters on monitors(2) and optimisation of lighting in the workspace. Lighting should be adjustable(2,7) and come from an indirect lighting source.(18) Reduction of clutter in the workspace(2) and removal of white coats in the reporting room(3) are also important as both have been shown to contribute to glare on VDUs. Occupational Health and Safety can also implement baseline ocular examinations or CVS questionnaires, with follow-up at regular intervals to evaluate for changes in vision and eye symptoms.

5. Conclusion:

Computer vision syndrome is a common problem among South African radiologists and is comparable to radiologists in other countries and computer users worldwide. With the continued shift to making use of Picture Archiving Systems and visual display units in practice, awareness of this occupational risk is invaluable to both the well-being of the individual and productivity of the worker. Both institutional buy-in, as well as implementation of personal practices can effectively combat these symptoms.

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7. List of Abbreviations:

CVS	Computer Vision Syndrome
VDU	Visual Display Units
PACS	Picture Archiving and Communicating System
RSSA	Radiological Society of South Africa
POPIA	Protection of Personal Information Act
OR	Odds Ratio

Appendix 1: Approved Protocol

Introduction

Statement of problem

As medical professionals, we face a large array of occupational hazards from exposure to infectious and hazardous biological materials to burnout. Certain occupational hazards such as exposure to ionising radiation are unique to the field of radiology.[1–3] While exposure to ionising radiation has been extensively studied, the shift in radiology towards the use of visual display units (VDUs) raises concerns about ocular hazards.

Justification of the study

Computer vision syndrome (CVS) is defined by the American Optometric Association as a "group of eye and vision related problems that result from prolonged computer, tablet, e-reader and cell phone use."[4] Many different terms have been used to describe this constellation of ocular symptoms, CVS being one, others include asthenopia, eye strain and ocular fatigue. It has been studied extensively in professions involving regular computer use. Despite this, there is limited research on the effects of VDU use among radiologists. This study aims to assess the prevalence of CVS in South African radiologists, raise awareness of the issue, and propose implementable solutions.

Literature review:

The widespread adoption of Picture Archiving and Communicating Systems (PACS) in radiology and the move away from film radiography exposes radiologists to potential ocular hazards.[1,5,6]

In 1990, legislation was enacted in Europe with regard to the occupational use of computers labelled Directive 90/270/EEC. This legislation places the onus on employers to inform their employees of the health and safety risks when using computers and to ensure that regular breaks are implemented. It is also a requirement that employees undergo regular eye tests.[2] While legislation in Europe has addressed computer-related occupational hazards, similar studies and regulations are lacking in South Africa. CVS is unlikely to result in permanent ocular damage, however, performance and diagnostic accuracy may be negatively affected.[7]

Studies worldwide have reported a high prevalence of CVS among VDU users, ranging from 32% to 90%.[1,8] A predilection for females has been shown.[9] Vertinsky *et al.* surveyed a

group of North American radiologists and the prevalence of eye strain was 36%.[7] Ayman *et al.* conducted a study in Saudi Arabia which showed a prevalence of CVS of 65.4% among radiologists.[1] To our knowledge, there have not been any studies conducted on this topic in South African radiologists. Considering this is a common problem globally, and particularly among radiologists, we expect that CVS will also be common among a South African cohort.

CVS encompasses a myriad of symptoms which can be divided into four categories – asthenopia, surface-related, visual and extra-ocular.[1,8]

1. Asthenopia refers to symptoms of eye strain and tired, painful eyes.[8]
2. Surface-related complaints include dry eyes, foreign body sensation or grittiness and burning of the eye and result from a decreased blink rate.[7,8,10] This is further exacerbated by ambient factors, such as air conditioning[10], and personal factors, such as contact lens use.[8,10]
3. Visual factors: when viewing a monitor at eye level, horizontal gaze is used, which results in a larger surface area of the cornea exposed to the environment. This differs from downward gaze, where the cornea is partially covered by the eyelids. Visual symptoms are described as diplopia, blurry vision, difficulty in focus and headaches.[8] These are concerning symptoms for doctors working in a field with high visual demands.
4. Extra-ocular symptoms include musculoskeletal symptoms such as back, neck and shoulder pain.[5,7,11,12]

Viewing of images on a VDU requires the use of a combination of multiple ocular pathways including accommodation, convergence and miosis. The above-mentioned symptoms related to CVS are generally temporary but may be bothersome especially towards the end of a long shift.[7,8]

CVS is more likely to occur in those who use screens for a long duration.[2,5,8] In radiologists, the use of VDUs for both reporting duties and administrative tasks, as well as the use of smart phones and devices significantly increases their risk of CVS.[1] Other contributing factors include air-conditioned offices, long hours in front of monitors and reduced blink rate from concentration. Reduction in blink rate predisposes to symptoms of dry eye – this is worsened by small font, low contrast and long periods of focus.[10,12] Contact lens use further compounds dry eye symptoms due to reduced production of tears during wear.[8,12] Junior radiologists, particularly registrars, are at higher risk for developing CVS in comparison to their senior counterparts. This is likely due to the relative inexperience of junior radiologists who require

more time to analyse images. The afterhours workload performed by junior staff adds additional strain on visual demands. This predilection for CVS in a younger demographic is unique to radiology, as the reverse is true in the general population where elderly computer users are at higher risk for CVS.[2]

Several strategies have been suggested to alleviate CVS symptoms. These strategies require both personal and institutional implementation. The widely described 20-20-20 strategy has been recommended to lessen the effect of CVS and requires individuals to focus on something 20 feet (6 meters) away every 20 minutes for 20 seconds to allow the eyes to rest.[2,7,8,12] Regular breaks are also suggested. This may seem counterintuitive to the productivity of a practice but regular breaks improve diagnostic accuracy and productivity as the effect of fatigue is lessened.[1,8,12] Regular eye examinations to correct refractive errors are important. Uncorrected refractive error can result in an increase in visual demand and further exacerbate fatigue.[1,5,8] Limiting the use of contact lenses in favour of spectacles is useful in combating the symptoms of dry eye.[12] Artificial tears can be used as an adjunct to alleviate these symptoms.[2,8,10] Use of blue light filtered spectacles has been described [8], however, there is a lack of robust data to support their usage and they remain a controversial tool in the prevention of visual strain. [11,13]

Ergonomics in the workspace is an important consideration when lessening the effects of CVS in radiologists and should be optimised for the individuals making use of the workstation.[5,7,8] In order to reduce the effects of eye strain, VDUs should be placed below eye level at a distance of 60cm – 100cm;[7,8] upward gaze increases accommodative strain which in turn exacerbates symptoms of CVS.[8] Adjusting the brightness and contrast of the monitor, [5,8] inspecting luminance of monitors and the placement of anti-glare filters on monitors can reduce symptoms of CVS, however, in reality these guidelines are not routinely implemented[8]. Ambient lighting should be adjustable so as to reduce glare on monitors[5,8] and the majority of workplace lighting should come from an indirect lighting source.[14] Other factors include reduction of clutter in the work space[8] and removal of white coats in the reporting room[7] as both have been shown to contribute to glare on VDUs.

CVS is emerging as a concern among South African radiologists, with potential implications for their work and health. Understanding the extent of this issue is essential for enhancing radiologists' working conditions and patient care. By conducting this study, we aim to

contribute valuable insights, raise awareness, and offer tangible solutions to enhance the overall well-being and performance of radiologists in South Africa.

Primary objective

To determine the prevalence of Computer Vision Syndrome among South African radiologists.

Secondary objectives

- To assess and describe any associations with eye strain amongst South African radiologists. Examples include subspeciality, ethnicity, gender, age, good ocular health habits etc.
- To identify factors contributing to ocular fatigue in radiology

Exploratory objectives

- To raise awareness among radiologists about the risks of Computer Vision Syndrome
- To propose practical solutions and recommendations to mitigate Computer Vision Syndrome symptoms in radiology practice.

Methods

Study design

This will be a cross-sectional observational study of South African radiologists using self-administered surveys.

Study population

A sample of convenience will be recruited using the Radiological Society of South Africa (RSSA) database. Notwithstanding bias inherent in convenience sampling, the RSSA database may be considered representative of South African Radiologists.

Power Calculations

Prevalence

To estimate the prevalence of CVS, we estimate the prevalence at 66%[15] and wish for precision of 5%. Using the following formula:

$$n = \left(\frac{Z^2 \times p \times (1-p)}{E^2}\right)$$

Where:

$n =$ required sample size

$Z =$ Z - score set at 1.96

$$p = \text{ Estimated prevalence}$$

$$E = \text{ margin of error (precision)}$$

This yields a minimum needed sample size of n = 345.

Assuming a drop-out rate of 10% due to exclusion criteria or response missingness,

$$n = 345 \times 1.1 \approx 380$$

To meet both objectives, a minimum of 380 participants ought to be recruited.

Inferential

For inferential statistics, we wish to detect an effect size of 20% between two proportions with Type 1 error rate of 5% and power of 80%. Using the following formula:

$$n = \frac{\left(Z_{(\alpha/2)} + Z_{\beta}\right)^2 \times \left(p_1 \times (1 - p_1) + p_2 \times (1 - p_2)\right)}{(p_1 - p_2)^2}$$

Where:

$$n = \text{ the minimum required sample size in each group}$$

$$\alpha = \text{ the type I error rate (0.05)}$$

$$\beta = \text{ the type 2 error rate (1- beta = power)}$$

$$p_1 = \text{ probability of outcome in group 1}$$

$$p_2 = \text{ probability of outcome in group 2}$$

This yields a minimum needed sample size of n=392

Assuming a drop-out rate of 10% due to exclusion criteria or response missingness,

$$n = 392 \times 1.1 \approx 432$$

To meet both objectives, a minimum of 432 participants ought to be recruited.

Inclusion criteria

- Radiology consultants registered to practice within South Africa
- Radiologists in training (registrars and medical officers)

Exclusion criteria

- Radiologists no longer in practice

Data collection and handling

- Participants will be invited to complete a previously validated online questionnaire, the *Computer Vision Syndrome Questionnaire* (Appendix B).
- Email reminders will be sent out at 1 week, 1 month and 3 month intervals.
- RedCap will be used to capture the data.

- This survey will remain anonymous; no names or identifying information will be collected.
- The following data will be collected (Appendix A):
    - Gender
    - Age
    - Ethnicity
    - Rank (Medical Officer, Registrar, Consultant)
    - Years in practice
    - Frequency of eye exams
    - Use of visual aids and type (contact lenses vs corrective spectacles vs blue light spectacles)
    - Working hours
    - Amount of after-hours work
    - Amount of time spent using PACS/VDUs
    - Amount of time reviewing film
    - Frequency of ocular symptoms
    - Severity of ocular symptoms
- Data will be captured on RedCap to comply with POPIA.

Data analysis

Data will be analysed using Rstudio. Prevalence of CVS will be calculated as the proportion of respondents with a score of ≥6 points from the Computer Vision Syndrome Questionnaire from the sample population.

Descriptive will calculate the median and inter-quartile range for continuous variables, and the frequency and proportion for categorical variables. Inferential statistics will be used to test for an association between CVS and response variables. Univariate logistic regression will be used to calculate the odds ratio (OR) between a score of ≥6 points from the Computer Vision Syndrome Questionnaire (indicating CVS), on each response variable. The OR along with corresponding 95% confidence interval, and p-value will be tabulated. Significance (α) will be set at 0,05.

Ethics:

The University of the Witwatersrand Human Research Ethics Committee (Medical) will review the study and provide clearance.

No identifying features will be collected, and the survey is completely anonymous.

Timing

	Aug	Sept	Oct	Nov	Mar	Apr	May	Jun	Jul	Aug	Sep
Literature review	X	X	X								
Protocol preparation	X	X	X								
Ethics application			X	X							
Protocol assessment			X								
Data collection						X	X	X			
Data analysis									X	X	
Write up											X

Funding:

No funding will be required for this study.

Limitations:

- If we are unable to obtain permission to make use of the validated Computer Vision Syndrome Questionnaire, the author will compile a list of questions to conduct the study.
- Those suffering from CVS may be more likely to respond to the survey and this might skew results with a response bias.
- A high response rate of 41.4% (total RSSA members = 1043 on 12/10/2023) will be required for the above-mentioned calculations.
- No identifying data will be collected, this may result in duplicate entries.

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Appendix 2: Self-Administered Survey

My name is Megan van Gensen, and I am conducting research evaluating eye strain or Computer Vision Syndrome and its effects on radiologists in South Africa for my MMed.

Completion of this survey is voluntary, and responses are anonymous. By completing the questions in this survey, you are consenting to the use of your responses in this research project.

Sex:

☐ Male

☐ Female

☐ Other

Age:

☐ <30

☐ 30 – 45

☐ 45 – 60

☐ >60

Self-Reported Ethnicity

☐ Black

☐ White

☐ Coloured

☐ Indian

☐ Asian

☐ Other

Rank:

☐ Medical Officer

☐ Registrar

☐ Junior Consultant (<5years)

☐ Senior Consultant (≥5 years)

Number of years in practice:

☐ <5 years

☐ 5 – 10 years

☐ 10 – 15 years

☐ 15 – 20 years

☐ 20 – 30 years

☐ > 30 years

Field in Radiology:

☐ General Radiology

☐ Subspeciality

- ☐ Interventional Radiology
- ☐ Neuroradiology
- ☐ Pediatric Radiology
- ☐ Mammography
- ☐ Musculoskeletal
- ☐ Ultrasound
- ☐ Fluoroscopy
- ☐ Cardiothoracic

Use of eyewear during working hours:

☐ None

☐ Predominantly contact lenses

☐ Predominantly spectacles (no blue light filter)

☐ Both spectacles (no blue light filter) and lenses

☐ Blue light lenses (either corrective or non-corrective)

Use of eye drops as lubricant:

☐ Yes

☐ No

Have you recently had an eye examination (either optometry or ophthalmology):

☐ Never

☐ In the last year

☐ 1 – 2 years

☐ > 2 years ago

Number of hours spent reviewing cases using a computer:

☐ < 4 hours

☐ 4-6 hours

☐ 6 – 8 hours

☐ > 8 hours

Number of hours spent reviewing cases on film:

☐ < 4 hours

☐ 4-6 hours

☐ 6 – 8 hours

☐ > 8 hours

How frequently do you take breaks while reviewing cases:

☐ Every hour

☐ 1-3 hourly

☐ >4 hourly

☐ Never

Appendix 3: Validated Computer Vision Syndrome Questionnaire

(Author Professor Maria Del Mar Segui from the University of Alicante)

Sublicense obtained from BiblioPro Europe

To be completed by worker

Indicate whether you experience any of the following symptoms during the time you use the computer at work. For each symptom, mark with an **X**:

a. First, the frequency, that is, how often the symptom occurs, considering that:

NEVER = the symptom does not occur at all

OCCASIONALLY = sporadic episodes or once a week

OFTEN OR ALWAYS = 2 or 3 times a week or almost every day

b. Second, the intensity of the symptom:

Remember: if you indicated NEVER for frequency, you should not mark anything for intensity.

	a. Frequency			**b.** Intensity	
	NEVER	OCCASIONALLY	OFTEN OR ALWAYS	MODERATE	INTENSE
1 Burning					
2 Itching					
3 Feeling of a foreign body					
4 Tearing					
5 Excessive blinking					
6 Eye redness					
7 Eye pain					
8 Heavy eyelids					
9 Dryness					
10 Blurred vision					
11 Double vision					
12 Difficulty focusing for near vision					

13 Increased sensitivity to light					
14 Coloured halos around objects					
15 Feeling that sight is worsening					
16 Headache					

Appendix 4: Participant Information Sheet

Good day

My name is Megan van Gensen, I am a registrar and MMed student in Diagnostic Radiology at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Sofia Ramos. I am conducting a research study about computer vision syndrome in South African radiologists. The study title is: **Ocular Health in Radiologists**: A comprehensive study evaluating Computer Vision Syndrome amongst South African Radiologists.

You are invited to take part in a validated survey.

If you decide to take part, you will be asked to complete a validated survey, which should take approximately 10 minutes to complete. As part of this survey, you will be asked to complete certain demographic information and questions pertaining to symptoms of computer vision syndrome and their frequency as well as severity. No identifying information will be collected.

Important to note:

1. A validated questionnaire will be sent via an online link for completion. Your participation in the survey indicates your consent and no further consent will be obtained.
2. Participation is voluntary. If you so choose not to take part in the survey, there will be no disadvantage or penalty to you. You may cease participation at any point during the survey and your information will not be used.
3. Information will be collected over a period of two months.
4. All information collected is confidential and no identifying information will be collected. No individual will be identified by name in any report or publication arising out of the study. All data collected in the course of the study will be securely retained for two years, if a scientific publication arises from the study and six years, if there is no publication. Thereafter it will be destroyed accordingly. All collected information will be kept on a secure network and password protected computer. Only the authors will have access to the information you have provided.
5. There is no direct benefit to participation in the study. The information will be used to determine the prevalence of computer vision syndrome and possible associations.
6. A summary of results can be provided, on request following completion of the study.
7. No reimbursement will be offered in exchange for participation in the study.

Contact details of researchers:

Dr Megan van Gensen: mvgensen@gmail.com, Tel: 072 271 7397
Dr Sofia Ramos (Supervisor): sofiaramos26@gmail.com, Tel: 083 723 6104

Outputs

Information collected in this survey will help to determine the prevalence and possible associations of Computer Vision Syndrome in South African Radiologists, to raise awareness among radiologists about the risks of Computer Vision Syndrome and to propose practical solutions and recommendations to mitigate Computer Vision Syndrome in radiology practice.

Contact details of HREC administrator and chair

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Paul Ruff, who may be contacted via any one member of the secretariat. The telephone numbers for the Committee secretariat are 011 717 2700/1234/2656/1252 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za, Rhulani.Mukansi@wits.ac.za, Mapula.Ramaila@wits.ac.za and Iain.Burns@wits.ac.za.

Thank you for reading this Study Information Sheet.

Appendix 5: Human Research Ethics Committee clearance certificate:

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

REC-250208-004 Dr Megan van Gensen, et al

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M240720

NAME: (Principal Investigator)	Dr Megan van Gensen, et al
DEGREE:	MMed (Diagnostic Radiology)
DEPARTMENT:	Radiation Sciences
STUDY SITE(S):	Online survey (Radiological Society of South Africa)
TITLE:	Ocular Health in Radiologists A comprehensive study evaluating Computer Vision Syndrome amongst South African Radiologists
DATE CONSIDERED:	26/07/2024
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	Original Application Number MED24-02-389. Subsequent Online Application Number M241217-A-0001.
SUPERVISOR:	Dr S Ramos
APPROVED BY:	Paul Ruff Professor P. Ruff, Chairperson, HREC (Medical)

DATE OF APPROVAL: 17/12/2024 **EXPIRY DATE:** 16/12/2029

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATOR(S)

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report** in the month date of convened meeting each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Email a signed copy of ethics clearance certificate to HREC-Medical.ResearchOffice@wits.ac.za.

Principal Investigator Signature — Date: 06/01/2025

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 6: Plagiarism Declaration

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Megan van Gensen (Student number: 2528636) am a student registered for the degree of MMed in Diagnostic Radiology in the academic year 2025.

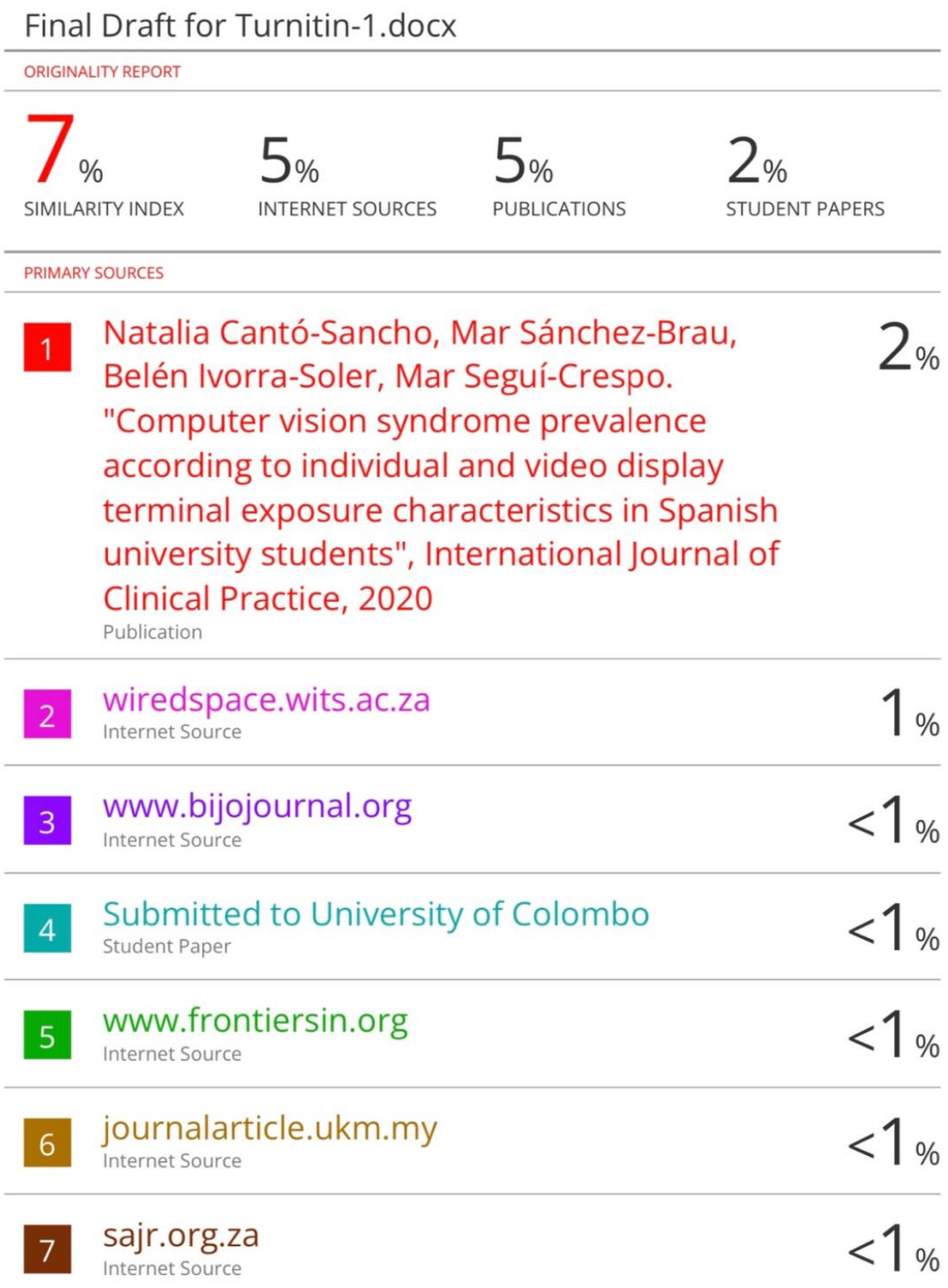
I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: 

Date: 3 May 2025

Appendix 7: Turnitin Report



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1	Natalia Cantó-Sancho, Mar Sánchez-Brau, Belén Ivorra-Soler, Mar Seguí-Crespo. "Computer vision syndrome prevalence according to individual and video display terminal exposure characteristics in Spanish university students", International Journal of Clinical Practice, 2020 Publication	2%
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symptoms in people with and without neck pain", Applied Ergonomics, 2019
Publication

19	Milad Qolami, Natalia Cantó-Sancho, Mar Seguí-Crespo, Elena Ronda-Pérez, Ali Mirzajani, Ghorban Taghizade. "Prevalence of Computer Vision Syndrome Among Iranian Medical University Employees and Graduate Students in their Occupational Environment", Function and Disability Journal, 2021 Publication	<1 %
20	Rui Li, Bowen Ying, Yingxiao Qian, Danni Chen, Xiaoxiao Li, Hui Zhu, Hu Liu. "Prevalence of Self-Reported Symptoms of Computer Vision Syndrome and Associated Risk Factors among School Students in China during the COVID-19 Pandemic", Ophthalmic Epidemiology, 2021 Publication	<1 %
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