

1 **Agreement in dry eye management between optometrists and general practitioners**  
2 **in primary health care in the Netherlands**

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18 **ABSTRACT**

19 **Purpose:** To investigate the agreement in dry eye care management between General  
20 Practitioners (GPs) and Optometrists in the Netherlands.

21

22 **Methods:** A web-based survey was used to investigate the agreement in symptoms  
23 associated with dry eye, causes of developing dry eye, and investigative techniques used in  
24 practice, between GPs and optometrists. Additional questions surveyed knowledge of the  
25 latest research, and co-management of dry eye disease in primary healthcare. The  
26 anonymised questionnaire contained 16 forced-choice questions with Likert scales, and  
27 was sent to 1471 general medical practitioners and 870 registered optometrists. The  
28 response data was stored on an online database, and was converted directly to text format  
29 for analysis using SPSS 21 statistical analysis software.

30

31 **Results:** 138 optometrists and 93 GPs responded to the survey (Cronbach  $\alpha = 0.885$ ,  
32 optometrists, and  $0.833$ , GPs). Almost no agreement was found for all the questions: a  
33 statistically significant difference (Chi-square  $p < 0.0001$ ) was found between the  
34 optometrists and GPs in the use of investigative techniques, associating symptoms, causes  
35 of dry eye ( $p > 0.0001$ ), and dry eye symptoms, except for 'burning sensation of the eye' and  
36 'irritation of the eye' as agreed symptoms, and agreement that dry eye is an age-related  
37 disease.

38

39 **Conclusions:** As the optometrist and the GP are the gatekeepers for secondary healthcare,  
40 the fundamental differences in the methods of investigation and interpretation of dry eye-  
41 related symptoms, the possible cause of developing dry eye disease, and the therapy given  
42 by GPs and optometrists in the Netherlands, may have a significant impact on consistency  
43 of patient care.

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45

46 **Introduction**

47 Dry eye disease (DED) is a multi-factorial chronic ocular disease, with significant impact on  
48 visual functioning and daily life. This highly symptomatic, chronic condition is experienced  
49 by patients in a variety of symptoms that range from ocular discomfort to pain, from an  
50 impaired visual performance to photophobia, and so careful questioning is important for  
51 good diagnosis [1]-[4]. The multi-factorial nature of DED makes it difficult to define in one  
52 symptom or by any single current investigative technique, and, most importantly, no single  
53 treatment works for all. Moreover, because of the multi-factorial origin of the disease,  
54 patient reported symptoms and diagnostic tests have poor correlation [5]-[8].

55

56 DED is described as a chronic disease, as acknowledged by both the Dry Eye Workshop  
57 Report (DEWS) and the Meibomian Gland Dysfunction Workshop (MGDW) Report. Both  
58 reports give guidelines on appropriate questioning, investigation and treatment of dry eye  
59 disease [5], [9]-[11].

60

61 Estimates for the worldwide prevalence of DED give a range from as low as 0.1% to as high  
62 as 33% [5]. In the Netherlands there is no prevalence data available, partly due to a lack of  
63 consensus in defining DED. However, by using indirect measurements, an estimate of the  
64 prevalence of the disease can be made. In 2013 there were 573,540 users (out of a  
65 population of 17 million) in the Netherlands of prescribed artificial tears products, as  
66 reported from the data bank of the Drug Information System of National Health Care  
67 Institute (GIP 2013). This does not take into account the number of non-prescribed artificial  
68 tears advised or patient self-management. Optometrists in the Netherlands can prescribe,  
69 and advise on, over-the-counter artificial tears available on the Dutch market, and patients  
70 can self-manage using over-the-counter artificial tears sold by pharmacists and drugstores.  
71 The prescription of artificial tears, which is often an inappropriate and ineffective treatment,  
72 costs in excess of 26 million euros in 2013, an increase of 35% since 2009 (GIP 2013).  
73 Prescribed artificial tears and related products are ranked at 29 of the top 100 medicines  
74 that cost the most for the health system, as calculated by the Dutch drug information  
75 system (GIP 2013). The number of users of artificial tears and related products is ranked at  
76 19 out of the 100 most prescribed medicines (GIP 2013).

77

78 The healthcare system In the Netherlands relies on triage of patients within the primary  
79 healthcare level, especially by the GP for treatment and referrals. The GP is said to be the

80 gatekeeper for secondary healthcare [12]. In the Netherlands, optometrists also have a role  
81 as a gatekeeper for referrals to ophthalmology. However, difficulties arise in the definition  
82 used in primary care for dry eye disease and no distinct criteria are available across primary  
83 healthcare in the Netherlands. This problem of definition used and examination done is  
84 investigated in several studies elsewhere and all describe wide variations among eye care  
85 practitioners and their scope of practice [3], [9], [13], [14]

86

87 In 2014, approximately 980 optometrists are registered with the Dutch Optometric  
88 Association (Optometrie Vereniging Nederland (OVN)). The total number of optometrists  
89 working in the Netherlands is unclear, but the OVN estimate that 90% of all optometrists are  
90 members, with approximately 70% of members working in primary healthcare. With a  
91 population of approximately 17 million, the number of optometrists in the Netherlands is low  
92 compared to the UK, where there are approximately 13,500 optometrists for a population of  
93 63.5 million. The total number of GPs working in the Netherlands in 2011 was estimated to  
94 be approximately 8800 [15].

95 The data collected from a survey undertaken by the OVN [9] (about the tasks and duties in  
96 diagnosing and treating red eye and tear film/dry eye-related disease in primary care)  
97 showed a strong opinion by ophthalmologists for letting the GP take charge in the  
98 investigation, diagnosis and treatment rather than the optometrist. However, this opinion  
99 was made without having a good overview of the impact of DED in primary care and the  
100 knowledge, equipment and skills of the optometrist in managing DED. It could be argued  
101 that, with the multi-factorial and chronic nature of dry eye disease and the possible  
102 environmental influences, the optometrist should be the first practitioner in the line of care.

103

104 In the literature, to our knowledge, there are no reports comparing the diagnosis and  
105 management of DED between GPs and optometrists. In contrast, the literature shows a  
106 generally good agreement in diagnosis and management between ophthalmologists and  
107 optometrists who have similar levels of education [16], [17].

108

109 The aim of this study is to investigate and determine the agreement between optometrists  
110 and GPs in relation to subjective dry eye symptoms, the causes of developing dry eye, the  
111 use of investigative techniques, and the treatment options used.

112

113 **Methods**

114 Using a cross-sectional design using a web-based questionnaire was developed to survey  
115 knowledge, investigative methods and therapy preference for patients with dry eye disease,  
116 using forced-choice questions and Likert scales.

117

118 Survey Design

119 An initial survey was designed, and a pilot study of 14 questions was sent by email to 12  
120 optometrists and 12 GPs who had some involvement in local initiatives for co-management,  
121 and had access to the internet. The questionnaire was hosted on the surveymonkey.com  
122 website, with password restricted access to the data. The access time for completing the  
123 survey was one month and one reminder was sent after 2 weeks. Eleven optometrists and  
124 five GPs completed the survey. The responses from these participants were not included in  
125 the main study. With feedback from this pilot study, a final version of the questionnaire was  
126 developed, consisting of 10 main questions (Table 1), which surveyed the knowledge,  
127 investigative methods and therapy preference for dry eye disease. The survey was  
128 designed in English, and translated into Dutch when used.

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**Questions 1 and 2 asked for estimates of patients seen**

1 How many patients do you see per week and how many dry eye patients do you see per week?

2 Can you give an estimation of the average age of patients in your practice with dry eye problems, divided according to those not wearing contact lenses and those wearing soft contact lenses?

**Question 3 asked for the use of specific dry eye questionnaires and was answered from 3 choices:**

**OSDI, McMonnies, and personally designed dry eye questionnaire.**

3. To aid diagnostics, do you use a dry eye questionnaire?

The following questions were forced-choice

**Question 4 was answered by Likert scales with five choices; not specific, sporadically, occasionally, most frequently, always**

4. Which of the following symptoms do you specifically associate with dry eye?

**Questions 5-8 were answered by Likert scales with five choices: never, sporadically, occasionally, most frequently, always**

5. Which of the following possible causes of dry eye do you see in your practice?

6. Which of the following investigative techniques do you use to diagnose dry eye?

7. Which of the following is the reason of development of dry eye in your patients?

8. What is the most commonly used/prescribed treatment after your diagnosis of dry eye?

**Question 9 was answered by forced-choice on a Likert scale with three choices: No, I do not know these investigations, Yes, but never read it in detail, Yes, have read some or have detailed knowledge of the articles.**

9. Are you aware of the most recent large scale research reports of dry eye, such as the Dry Eye Workshop (DEWS) or Meibomian Gland Disease (MGD) workshop

**Question 9 was answered by forced choice, yes or no**

10. Are you working together with an optometrist or GP (co-management) in your area specifically for dry eye management?

146 Table 1: Survey questions investigating knowledge, investigative methods, therapy  
147 preference and experience of GPs and optometrists.

148

149 Recruitment

150 Optometrists: An invitation email with details of the internet link to the survey was sent to all  
151 optometrists registered with the OVN (Optometrie Vereniging Nederland, n = 870). Access  
152 to the survey was permitted from November 2012 to March 2013. In the invitation,  
153 participants were asked to fill in the survey if they were working mainly in primary  
154 healthcare, since the scope of practice for an optometrist working in secondary (in  
155 ophthalmology offices) or tertiary healthcare (low vision or therapeutic lenses) will be  
156 different if they are working in direct consultation with an ophthalmologist, and have access  
157 to therapeutics (directly or indirectly) prescribed by ophthalmologist. The patients they see

158 may also differ in severity and co-morbidity of eye diseases to those more commonly seen  
159 in primary care practice. According to the OVN, 70% of Dutch optometrists work in primary  
160 healthcare, giving a total cohort size of 609 subjects.

161

162 GPs: Paper copies of the survey, along with details of the internet link to the survey and an  
163 invitation to participate in the study, were sent by general mail to the 224 offices of the HAP  
164 (HuisArtsen Post) in the Netherlands. (HAP is the main out-of-hours GP Service in the  
165 Netherlands). The survey was sent between November 2012 and January 2013. A direct  
166 email invitation, with details of the internet link, was also sent to 1471 email addresses  
167 collected from an open access internet site for internship placements for GPs. The GPs  
168 were selected from each province of the Netherlands working in primary healthcare, and  
169 the email invitation was sent from February 2013 to July 2013.

170

#### 171 Ethical approval

172 For ethical approval, each English version was translated into Dutch and screened by a  
173 native English-speaking Dutch optometrist and colleague at the Hogeschool Utrecht, and  
174 then translated back to English. Only the final questionnaire was sent to the Ethics  
175 Committee. The study was approved by the Research Ethics Audit Committee of the  
176 School of Optometry and Vision Sciences at Cardiff University and was consistent with the  
177 tenets of the Declaration of Helsinki. Access to the survey was secured using a login code  
178 and password. Only the researcher had access to the data. The data was stored on an  
179 online database, and was converted directly to text format for analysis using the SPSS 12.1  
180 statistical analysis software program.

181

#### 182 Statistical methods and analysis variables

183 Cronbach's alpha, a coefficient of consistency, was used to measure internal consistency of  
184 the questions per group. Descriptive statistics were used to describe the demographic data  
185 for the first two survey questions using median, means and standard deviations. A  
186 Pearson's Chi-square test was used to compare differences in given answers among the  
187 GPs and Optometrists. A p-value of less than 0.05 was considered to denote statistical  
188 significance. Frequency tables were constructed for both GPs and optometrists for each  
189 question to provide an overview of the responses given. The Kendall W test (or Kendall's  
190 coefficient of concordance for ranks) was used to value the agreement amongst GPs and  
191 optometrists, with zero indicating no agreement and one indicating complete agreement.

192 **Results**

193 Optometrists: Of the 861 emails sent by the OVN, 25 were returned with a wrong or not  
194 usable email address, or from a full inbox. Of the 836 optometrists reached, 138 responded,  
195 giving a response rate of 16.3%. Based on a possible primary healthcare cohort of 609 then  
196 the response rate for that cohort sub-group would be closer to 22%.

197

198 GPs: Of the 1471 GP email addresses, 81 rejected the email and 59 emails bounced. In  
199 total, 1331 GPs were reached by email and of those a total of 93 GPs completed the survey,  
200 to give a response rate of 7%. Of the 93 completed surveys, 77 GPs used the direct access  
201 link to the survey, 14 responded indirectly by going online to the survey website, and 2 sent  
202 a completed print version by regular post.

203

204 The survey results for each subject cohort showed good internal consistency, with a  
205 Cronbach alpha coefficient reported of 0.833 for the GPs and 0.885 for the optometrists.

206

207 Patient demographics

208 A comparison of the median number of general patients seen per week by optometrists and  
209 GPs shows that the number for the GPs is almost double that for the optometrists: the  
210 median patients seen per week by the GP was 105 and by optometrist was nearly 42  
211 (41.97). However, while the estimated number of dry eye patients seen per week was  
212 approximately 2 (1.78) patients per week for the GP, it was almost 14 patients per week for  
213 the optometrist (Table 2).

214

215 The estimated average age of dry eye patients seen without soft contact lens wear was  
216 significantly different between the GPs (nearly 61 years) and the optometrists (nearly 56  
217 years) ( $p=0.011$ ), although still of a similar age. Likewise, the average age of the patients  
218 with dry eyes and wearing soft contact lenses was significantly different, with GPs at almost  
219 39 (38.57) years and for optometrists at 40 years of age ( $p=0.03$ ), but this was not clinically  
220 significant (Table 2).

221

222 Use of Dry Eye Questionnaire

223 Analysing this question with the Pearson chi-square showed no statistical significant  
224 difference between optometrists and GPs for the use of either the OSDI ( $p=0.147$ ) or  
225 McMonnies ( $p=0.403$ ) questionnaires. A significant difference was found for the use of a



226 personalised questionnaire ( $p < 0.01$ ), with the optometrist more frequently using  
 227 personalised questionnaires (40% of the optometrists vs none of the GPs).

228

	Median number of patients seen per week	Average number of dry eye patients seen per week	Average age dry eye patients not wearing soft contact lenses	Average age dry eye patients wearing soft contact lenses
<b>GPs</b>	n=87 105 patients	n=86 78 patients sd 1.77	n=71 61.41 years sd=9.5	n=45 38.57 years sd=10.5
<b>Optometrists</b>	n=136 41.97 patients	n=110 13.94 patients sd=11.85	n=88 55.9 years sd=9.47	n=85 40 years sd=7.79
<b>P value</b>	P>0.00	P>0.00	P=0.03	P=0.011

229 Table 2: Demographic data patients seen per week (n = number of participants completing the  
 230 question).

231

232 Symptoms for dry eye

233 A statistically significant difference ( $p < 0.0001$ ) was found between optometrists and GPs, in  
 234 judging which patient symptoms they specifically associated with dry eye, for: itching of the  
 235 eye, transient vision changes, sticky eyelids in the morning, pain sensation in the eye, pain  
 236 around the eye, photophobia, eyelid hyperaemia, bulbar conjunctiva hyperaemia, skin  
 237 disease (e.g. acne rosacea), and asthenopia. For these symptoms, GPs were less likely to  
 238 link them with dry eye. However, for the symptoms of 'burning sensation of the eye' and  
 239 'irritation of the eye' ( $p = 0.073$  and  $p = 0.298$ , respectively) there was closer agreement for  
 240 both practitioners that these symptoms are an indication for dry eye.

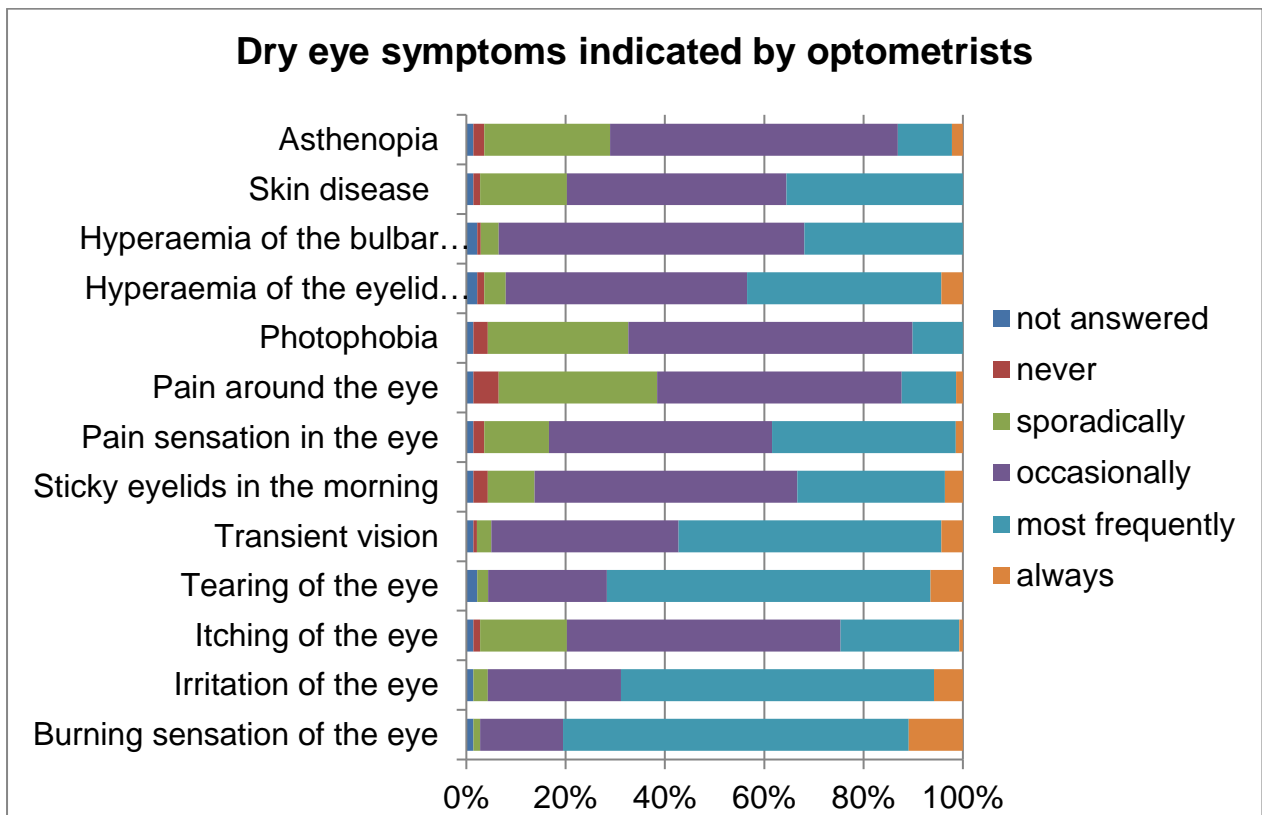
241

242 Using Kendall's W coefficient to assess the consistency of agreement within the  
 243 optometrists across the symptoms, a coefficient of 0.291 was found, indicating only a small  
 244 level of agreement. A similarly low coefficient of 0.390 was found for the results of the GPs.

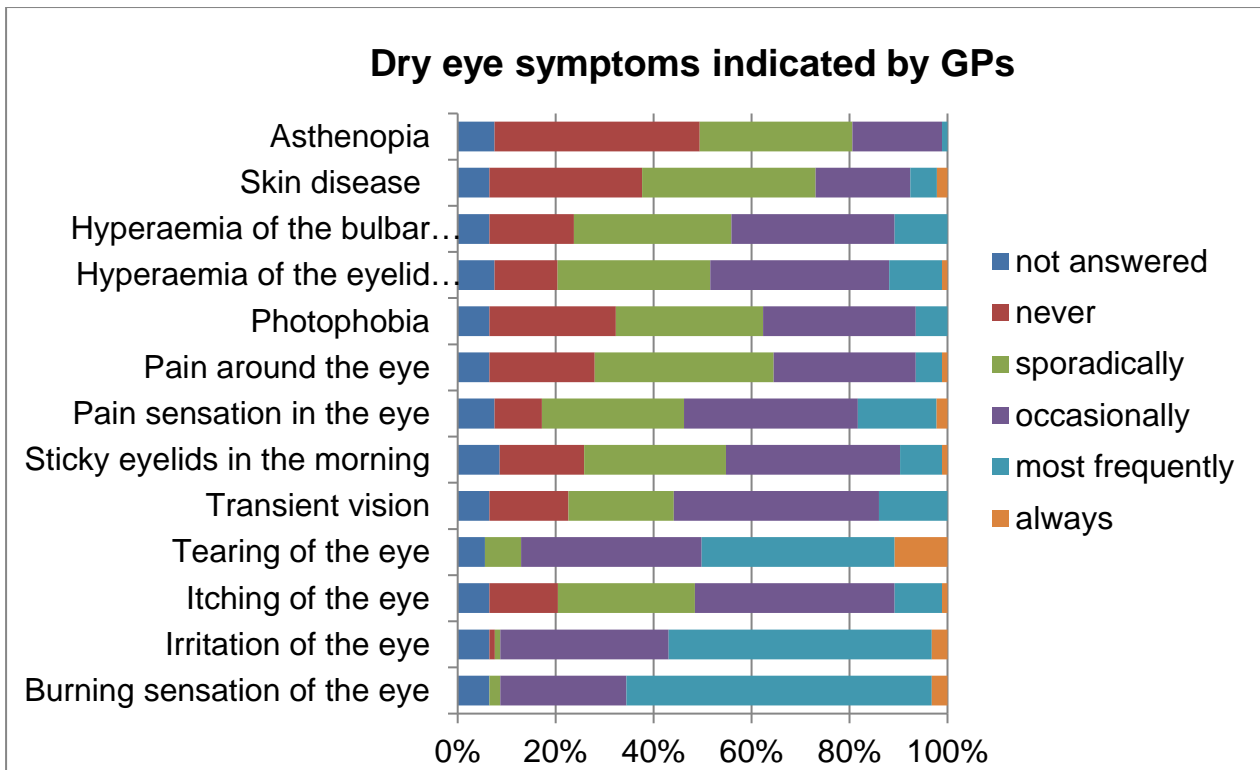
245

246 The mean rank of all symptoms showed that burning sensation of the eye, irritation of the  
 247 eye and tearing of the eye were ranked highest by the GPs, while for the optometrist the

248 mean ranked top three were burning sensation, tearing, and irritation of the eye. The  
 249 frequency tables for the survey answers are given graphically in Figures 1 and 2.  
 250



251  
 252 Figure 1: Percentage agreement for dry eye symptoms indicated by optometrists  
 253



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255 Figure 2: Percentage agreement for dry eye symptoms indicated by GPs

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257 Causes of dry eye disease

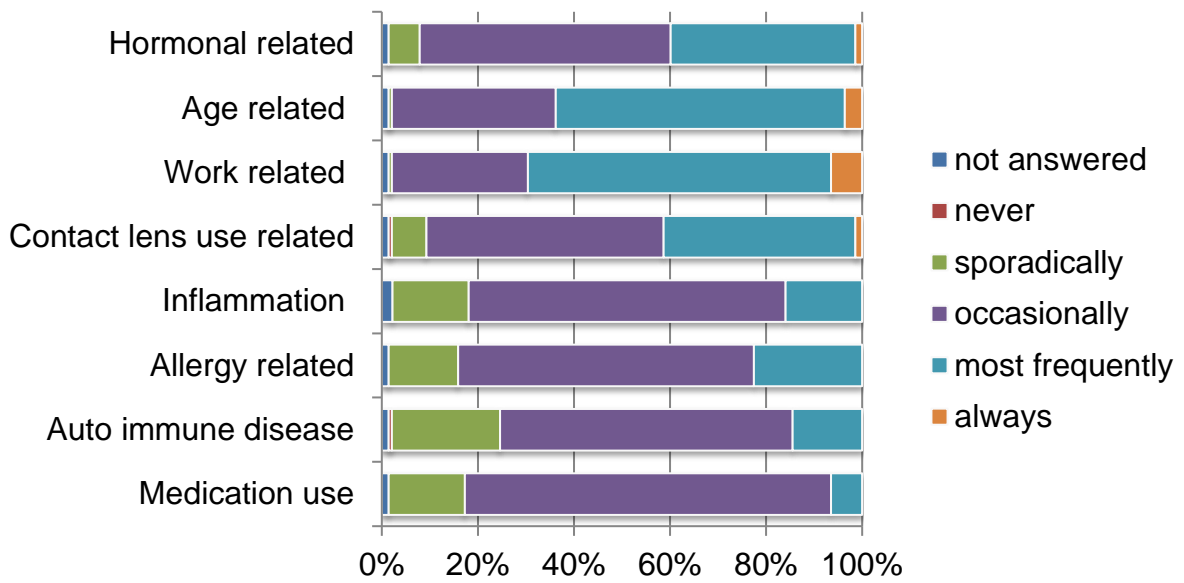
258 Of the possible causes for dry eye in patients attending their practice, no significant  
 259 difference in expectation was found between GPs and optometrists when diagnosing dry  
 260 eye as an age-related disease. For all other possible causes: medication use ( $p < 0.001$ ),  
 261 auto-immune ( $p < 0.004$ ), allergy-related ( $p < 0.0001$ ), inflammation ( $p < 0.0001$ ), work-related  
 262 ( $p < 0.0001$ ), contact lens use-related ( $p < 0.0001$ ), and hormonal-related ( $p < 0.0001$ ), there  
 263 was a statistically significant lack of agreement between the optometrists and GPs. In  
 264 general, the optometrists showed more variance in describing the causes of dry eye.

265

266 Optometrists indicated work-related (highest score), age-related and hormonal-related  
 267 causes as the main reasons for developing dry eye. The highest mean ranking for the GPs  
 268 was age-related, then work-related causes and contact lens use. The Kendall W coefficient  
 269 shows some concordance (0.311) for optometrists, with GPs showing a slightly lower  
 270 concordance (0.304) (Figures 3 and 4).

271

### Causes of development of dry eye; optometrist



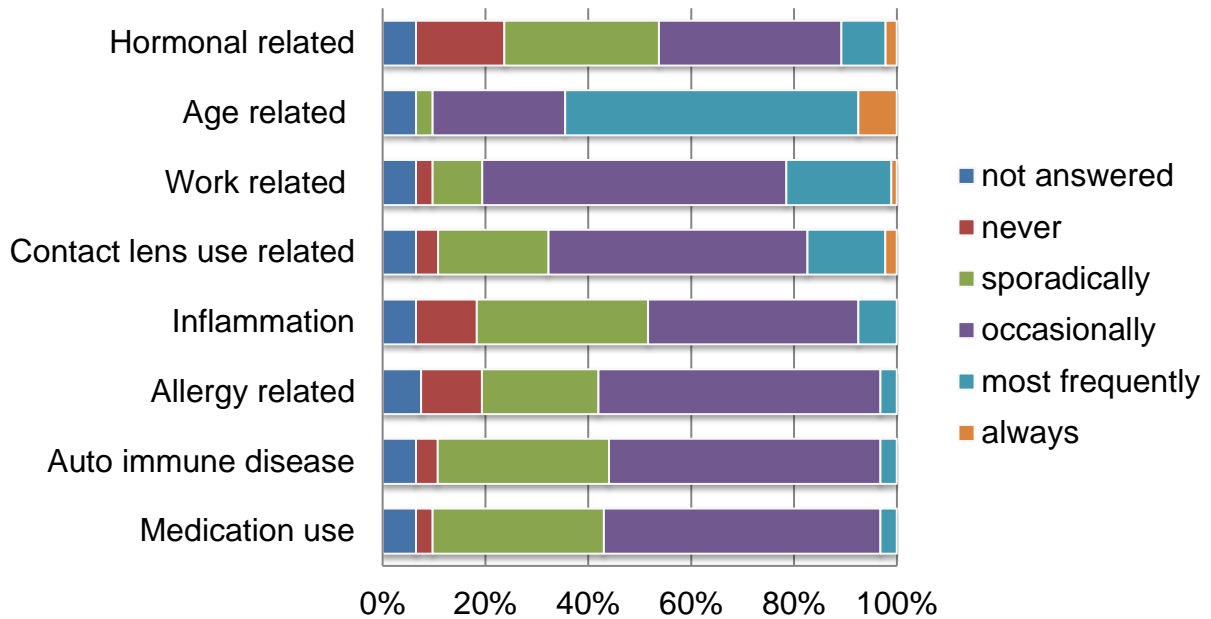
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Figure 3: Causes of development of dry eye reported by optometrists

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### Causes of development of dry eye; GPs



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Figure 4: Causes of development of dry eye reported by GPs

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#### Reasons for developing dry eye

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The frequency tables of reasons for developing dry eye reported by optometrists showed a tendency towards Meibomian Gland Dysfunction (MGD), with MGD showing the highest mean ranking, followed by anterior blepharitis and soft contact lens wear. There was a low

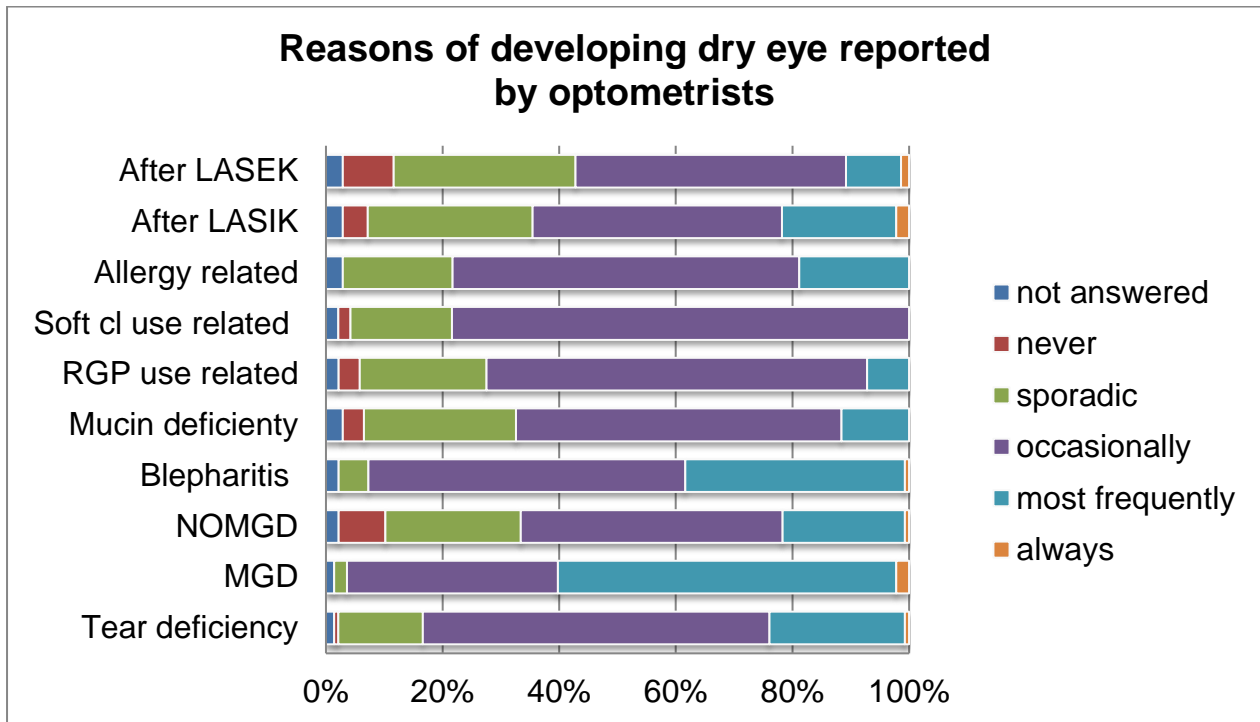
281

282 agreement for this question among optometrists (Kendall's W concordance 0.178) (Figures  
 283 5 and 6).

284

285 The highest mean rank for the GPs was tear deficiency, followed by soft contact lens wear  
 286 and RGP (rigid gas permeable) wear. The overall agreement between the GPs was higher  
 287 than the optometrists, but still low in general (0.313).

288



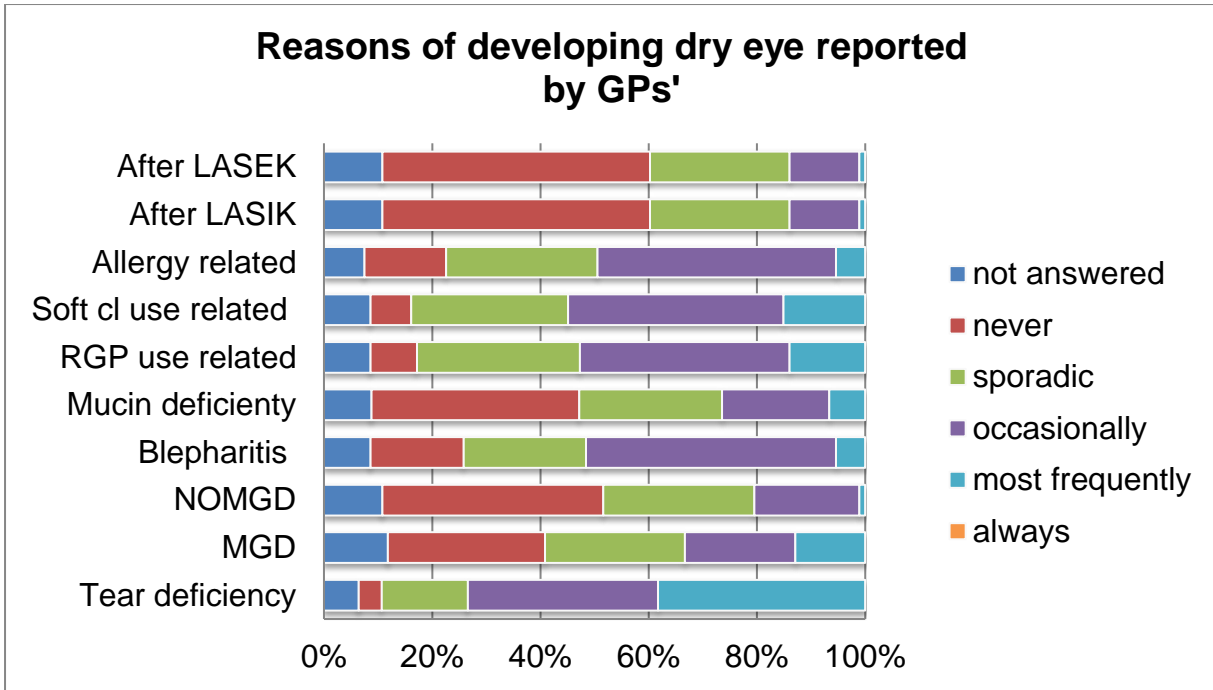
289

290 Figure 5: Percentage agreement in reason for developing dry eye indicated by optometrists

291 NOMGD: Not obvious meibomian gland dysfunction; MGD: Meibomian gland dysfunction;

292 Soft cl use: Soft contact lens use; RGP; Rigid gas permeable

293



294

295 Figure 6: Percentage agreement in reason for developing dry eye indicated by GPs

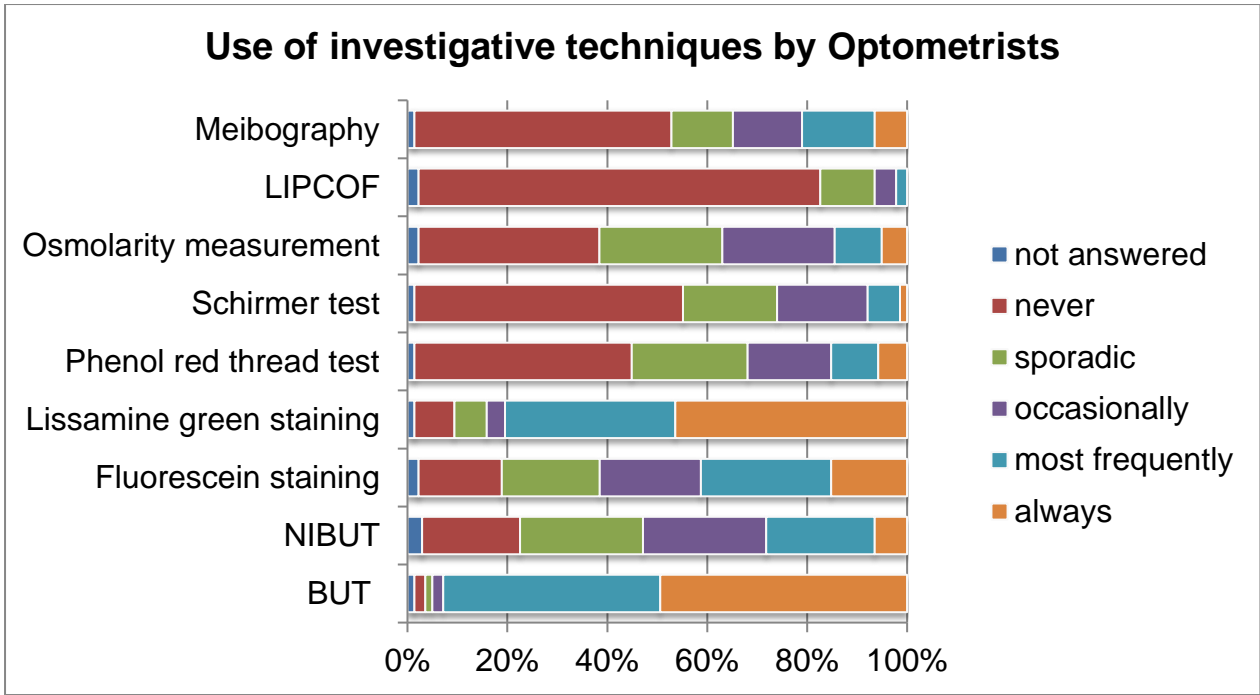
296 NOMGD: Not obvious meibomian gland dysfunction; MGD: Meibomian gland dysfunction;

297 Soft cl use: Soft contact lens use; RGP; Rigid gas permeable

298

299 Use of investigative techniques

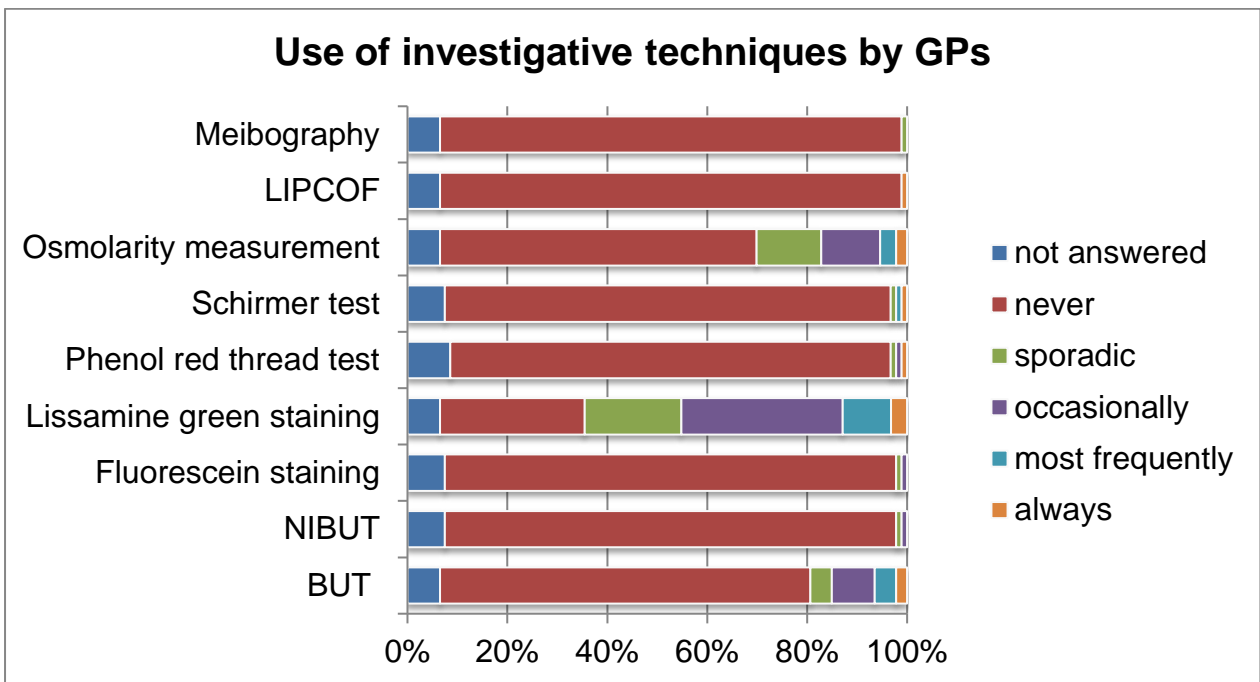
300 No agreement was found between GPs and optometrists on the use of investigative  
 301 techniques for dry eye diagnosis ( $p < 0.001$ , Chi-square test). While Figure 7 shows that the  
 302 optometrists use a variety of tests, Figure 8 shows that the GPs rarely use any of the  
 303 diagnostic tests. The top three mean ranked diagnostic test by the optometrists were tear  
 304 break-up time (BUT), lissamine green staining and fluorescein staining, and for the GPs,  
 305 were lissamine green staining, osmolarity measurement and BUT testing. As for osmolarity  
 306 measurements, out of the 87 GPs who answered this question, only 2 answered 'always'  
 307 (2.3%), 3 answered 'most frequent' (3.4%), and 59 (67.8%) answered 'never'. Of all the  
 308 other tests, the percentage of 'never using the test' dominated the outcome strongly. The  
 309 Kendall's W test agreement for diagnostic test use by the GPs was 0.425, compared to  
 310 0.504 for the optometrists.



311

312 Figure 7: Percentage agreement for use of investigative technique, indicated by  
 313 optometrists. LIPCOF: Lid parallel conjunctival folds; NIBUT: Non-invasive break-up time;  
 314 BUT: Break-up time

315



316

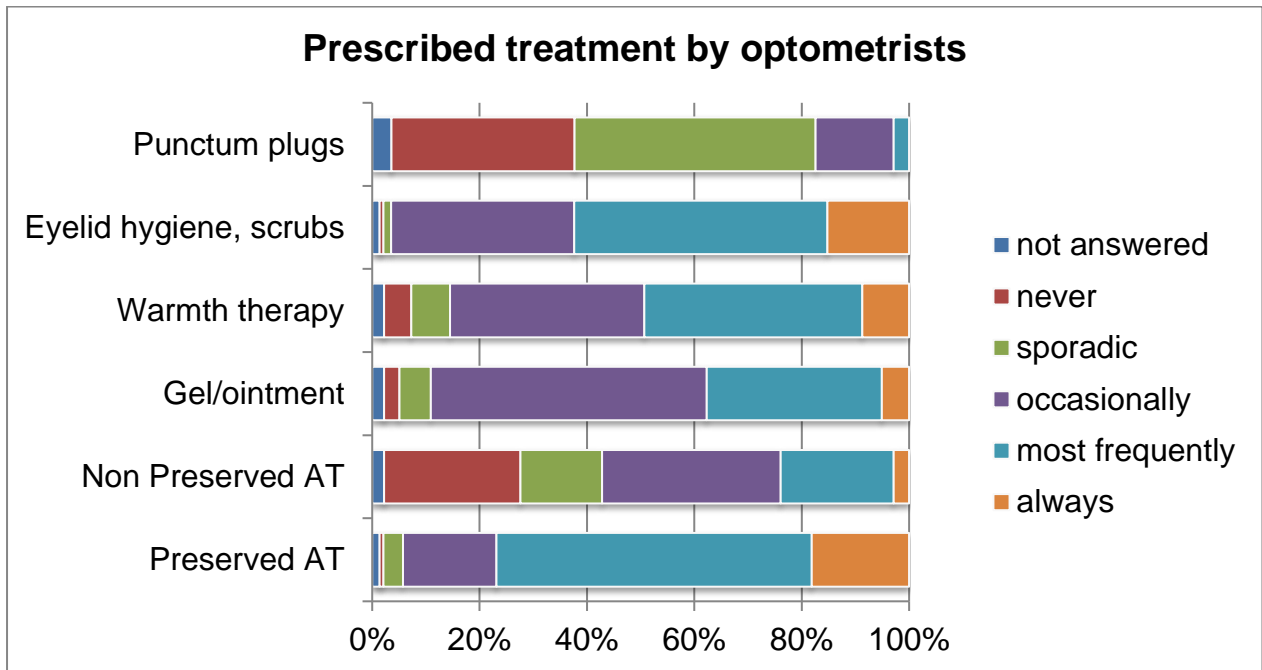
317 Figure 8: Percentage agreement for use of investigative technique, indicated by GPs.  
 318 LIPCOF: Lid parallel conjunctival folds; NIBUT: Non-invasive break-up time; BUT: Break-up  
 319 time

320

321 Prescribed treatment

322 The most commonly used treatment of dry eye after diagnosis was investigated to discover  
323 habitual treatment methods. A statistically significant difference was found between the  
324 GPs and optometrists for preserved artificial tears, unpreserved artificial tears, heat therapy,  
325 eyelid hygiene and punctum plugs ( $p < 0.000^*$ ), except for gel/ointment ( $p = 0.764$ ) (Figures 9  
326 and 10).

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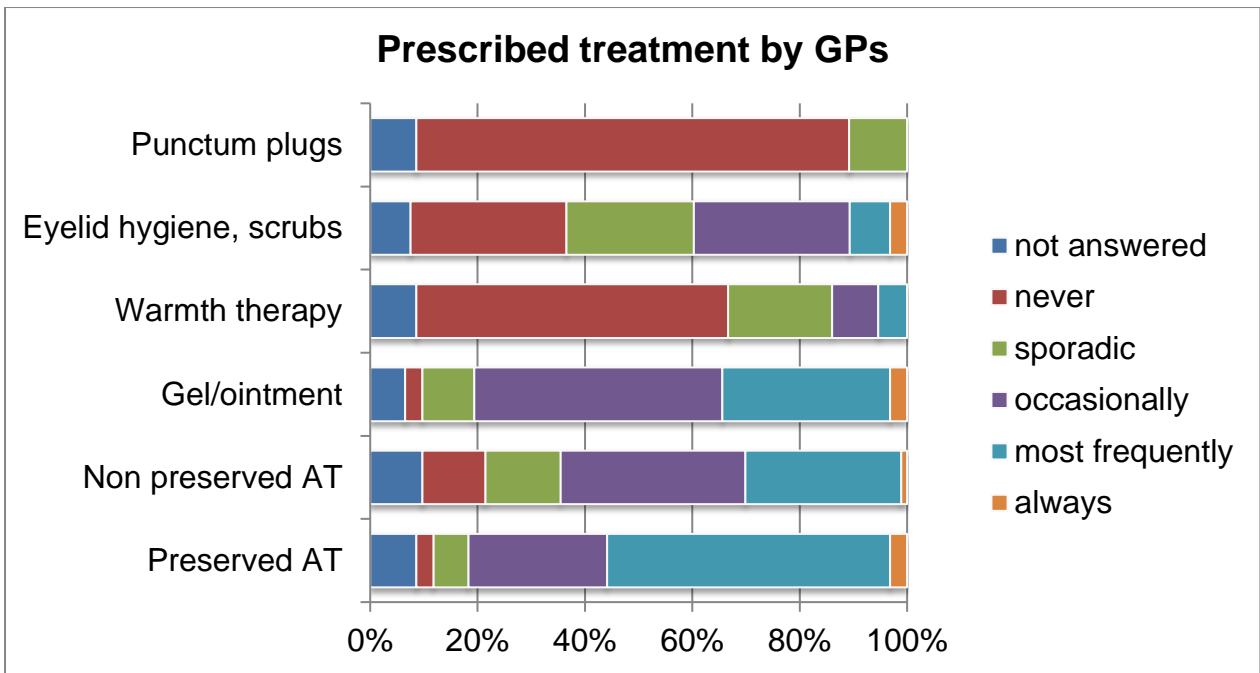


328

329 Figure 9: Prescribed treatment by optometrists, AT=Artificial tears

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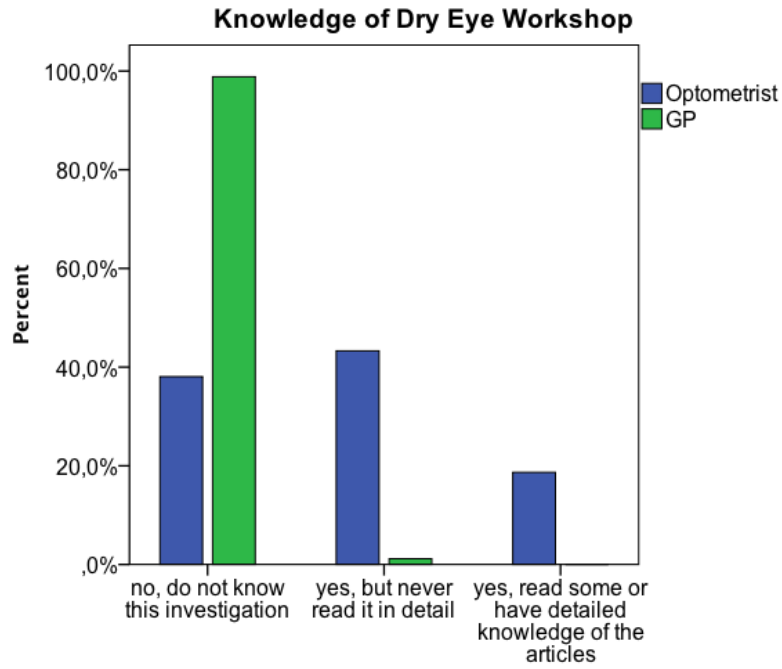
332 Figure 10: Prescribed treatment by GPs, AT=Artificial tears

333

334 Knowledge of recent research of dry eye disease

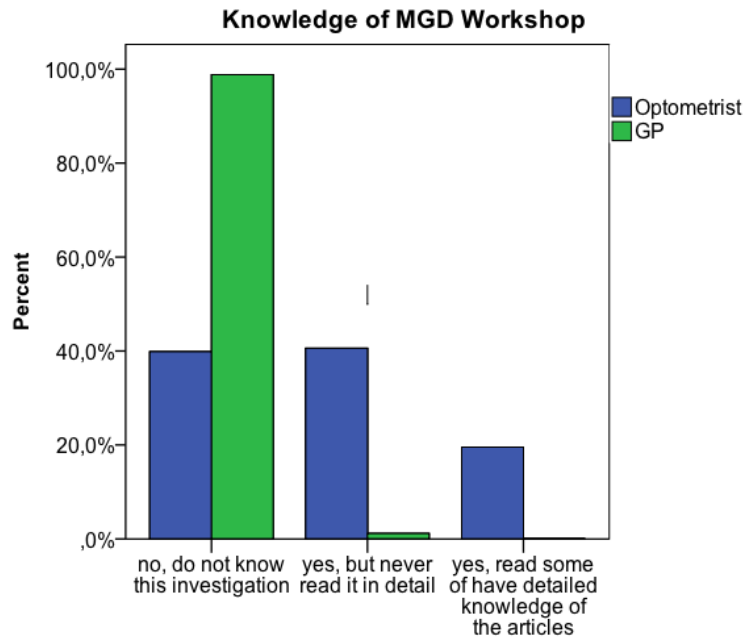
335 When specifically asked about their knowledge of the Dry Eye Workshop Report (DEWS)  
 336 and the Meibomian Gland Disease Workshop Report (MGDW), there was a statistically  
 337 significant difference between the GPs and optometrists ( $p=0.010$ ). The GPs had no  
 338 knowledge of either the DEWS or MGDW report (Figures 11 and 12), and while the  
 339 optometrists showed more awareness of both reports, they had a weakness in detailed  
 340 knowledge.

341



342  
 343 Figure 11: Percentage agreement for knowledge of the DEWS report indicated by GPs and  
 344 optometrists

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346  
 347 Figure 12: Percentage agreement for knowledge of the MGD Workshop report indicated by  
 348 GPs and optometrists

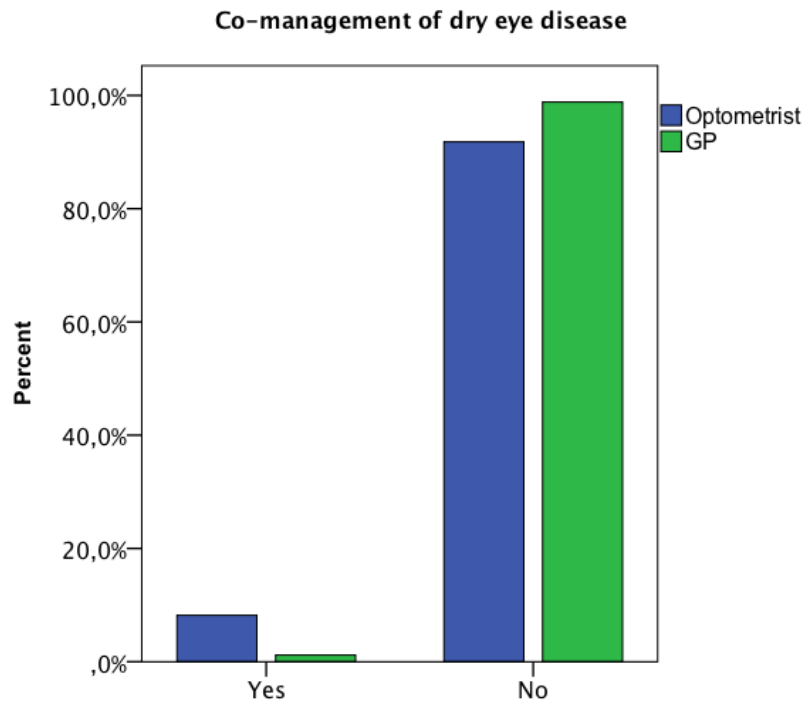
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350

351 Co-management of dry eye in primary healthcare

352 Both optometrists (91.8%) and GPs (98.8%) reported that that they did not frequently work  
353 together in the co-management of dry eye patients.

354



355 Figure 13: Percentage agreement for co-management of dry eye indicated by GPs and  
356 optometrists  
357

358

359 **Discussion**

360 This survey has generated a better understanding of the daily practice of optometrists and  
361 GPs in the diagnosis and management of patients with dry eye disease in the Netherlands.  
362 Prior to this survey no information was available on the attitude and method of care delivery  
363 for patients suffering from dry eye in the Netherlands when seen by optometrists or GPs.  
364 Indeed, to our knowledge, no research has been published that compares these two  
365 primary healthcare practitioners in the management of DED. There are several important  
366 findings that arise from the survey which have implications for future development of clinical  
367 care guidelines for the management of DED in the Netherlands. These findings also have  
368 relevance to primary healthcare clinical practice elsewhere.

369

370 The survey found significant differences between GPs and optometrists in the number of

371 patients seen during a working week. Although some responses indicated having over 500  
372 patient contacts per week, which seems excessive and may suggest a mis-understanding  
373 of the question, the relative differences between GPs and optometrists are clear. The  
374 median number of patients seen by the GPs during a week was 105 patients, and the  
375 median for the optometrist was 42. However, the number of dry eye patients seen per week  
376 was higher for the optometrist than for the GP: the GP saw on average 1.78 patients with  
377 dry eye symptoms, while the optometrist saw almost 14 patients a week. This latter  
378 difference may be because patients are more likely to report dry eye to an optometrist, or  
379 that the optometrist is more likely to ask about symptoms. The finding that the optometrist  
380 considers a wider variety of symptoms when making their diagnosis supports this  
381 perspective. Interestingly, the GPs results show a small standard deviation (1.77) compared  
382 to the optometrists (11.84) in dry eye patients seen. The small GP standard deviation  
383 suggests that seeing fewer dry eye patients is a consistent experience, whereas the greater  
384 variation for the optometrist might reflect the variety in the scope of practice for optometrists,  
385 some of whom might be working in a contact lens practice.

386

387 Despite a statistical difference, the similarity in patient age with dry eye symptoms without  
388 contact lens wear by both GPs (nearly 61 years) and optometrists (nearly 56 years) reflects  
389 one of the fundamental characteristics of dry eye disease – that its incidence is age-related.  
390 One of the best-known risk factors for developing dry eye is that it is more commonly found  
391 in patients aged 40 years and above [1]-[8], [18]. The GPs and the optometrists were also  
392 similar on a younger average age, of 40 years, for soft contact lens wearers attending with  
393 dry eye symptoms. This is consistent with the latest findings in the Contact Lens Discomfort  
394 Workshop Report (CLDW) that contact lens wearers, compared to dry eye patients,  
395 experience more dry eye-related problems at a younger age [5], [9]-[11], [19]. Indeed, the  
396 first reporting of dryness symptoms during contact lens wear is typically around 20-30 years  
397 of age [5], [20], and research shows that contact lens wear in a younger age population is a  
398 risk factor for ocular surface dryness-related problems [12], [21].

399

400 It is difficult to determine the real number of patients seen by both GPs and optometrists  
401 who have dry eye, but are not recognised as such. Generally, symptom questionnaires  
402 show the highest sensitivity and specificity for dry eye diagnosis supported with diagnostic  
403 tests [3], [9], [13], [14], [22]. In this investigation no specific questionnaire was used for DED,  
404 and the optometrists often used personally designed questionnaires. This lack of uniformity

405 could cause problems in communication between optometrists and GPs. The difference in  
406 diagnostic approach between GPs and optometrists may be observed through the  
407 symptoms that they each recognise as being specific for dry eyes, with only *burning*  
408 *sensation* and *irritation of the eye* seen by both as a specific symptom for dry eye. The use  
409 of the other symptoms was statistically significantly different. Interestingly, there was a  
410 wider spread of symptoms recognised by the optometrists, who agreed less with each other  
411 than did the GPs, who had a shorter list of diagnostic symptoms. This might be accentuated  
412 if the survey responses for optometrists came from those in more specialised practice  
413 versus more general practice optometrists.

414

415 The frequency tables of reasons for developing dry eye reported by optometrists showed a  
416 tendency towards Meibomian Gland Dysfunction (MGD), with MGD showing the highest  
417 mean ranking, followed by anterior blepharitis and soft contact lens wear. The highest mean  
418 rank for the GPs was tear deficiency, followed by soft contact lens wear and RGP (rigid gas  
419 permeable) wear. Interestingly, the higher ranking by the GPs for tear deficiency as a cause  
420 was not reflected in their response to the use of a specific diagnostic test, in particular to  
421 the use of the Schirmer test to confirm this as a possible reason. To detect MGD and  
422 anterior blepharitis, the use of a slit-lamp to provide a magnified view of the ocular surface  
423 as routine investigation technique is recommended, but this is usually only available to  
424 optometrists. When comparing the use of diagnostic tests, no agreement was found  
425 between optometrists and GPs. Indeed, GPs do not perform diagnostic tests as often as the  
426 optometrists. This may be due to having less time for each patient visit and/or limited  
427 access to specialised equipment needed.

428

429 Although more common for the GPs, the use of the Schirmer test by the optometrists was  
430 not a favourite. This may reflect a greater awareness by optometrists that the Schirmer test  
431 is no longer the first test used in diagnosing DED [15], [23]. Nichols et al (2000) found that  
432 only 8.5% of ophthalmologists in the USA used the Schirmer test for diagnosing dry eye  
433 disease. The study also identified symptoms as the most preferred single test for  
434 diagnosing dry eye disease, with fluorescein staining second [1], [9]. The Schirmer test was  
435 also preferred as the third or fourth diagnostic test by Spanish optometrists and  
436 ophthalmologists [2], [16], [17], and Australian optometrists also reported limited use of the  
437 Schirmer I (5%), or Schirmer II test (3%) [13]. A much better overall diagnosis for dry eye is  
438 to use a combination of tests. Both Gardona et al. 2011 [2] and Pult et al have reported that

439 there is a need to combine tests with a dry eye questionnaire to increase specificity and  
440 sensitivity in DED diagnosis [6].

441

442 For the possible causes of developing dry eye, the only agreement between the GPs and  
443 optometrists was with age-related, which was the top rank, which is consistent with the  
444 average age of DED patients they see in practice. Using the mean ranking, both the  
445 optometrists and GPs had work-related causes in their top three highest mean ranking.  
446 Although not shown statistically, the work-related cause may arise from common  
447 experience, since patients may complain of dry eye issues while at work [24]. The  
448 optometrists gave hormonal changes as a factor for developing dry eye, while the GPs had  
449 this cause as their lowest mean rank. Hormonal changes have been discussed as a  
450 possible cause for developing dry eye [25]. The female sex, blood oestrogen levels and the  
451 menopause are known as predictors in developing dry eye [26].

452

453 Looking at the survey results generally, the GPs have a less extreme range of opinions  
454 than the optometrists, which could be explained by differences in knowledge and/or  
455 specialisation between the two healthcare professionals. Or it could be due to a lower level  
456 of knowledge about dry eyes among the GPs. Also the work experience of both professions  
457 was not taken into account and this could influence their responses. Similarly, the  
458 population type and average age of the patients seen in routine practice could also  
459 influence the answers given. A study investigating diagnosis of eye pathology and dry eye  
460 disease between GPs and Ophthalmologists in the UK found that these were all factors, but  
461 any similar study has not been done in the Netherlands, to the authors' knowledge [27].

462

463 More GPs did not complete all the questions. For the investigative techniques this can  
464 reflect either that the tests were unfamiliar, that the tests are not used in a normal GP  
465 practice, or that they are seen as being unusable in a GP practice. In general, the trend in  
466 this study is that the GPs do not frequently use any of the diagnostic tests. There were also  
467 some unusual answers for a few GPs who report using tests for diagnosing dry eye disease,  
468 such as lissamine green, osmolarity measurement and BUT – osmolarity measurement is  
469 not a common test, nor is the use of lissamine green compared to the more commonly used  
470 fluorescein.

471

472 In the survey of treatment options, agreement was only found between optometrists and

473 GPs in the prescribing of gel/ointment. Also, the optometrist more often prescribed artificial  
474 tears without preservatives, while the GPs prescribed them with preservatives. The  
475 reluctance to use artificial tears with preservatives by optometrist could reflect a greater  
476 awareness of the latest opinions about preservatives [28]. In contrast, the GPs motivation  
477 may be influenced by the fact that artificial tears with preservatives can be reimbursed by  
478 health insurers, although this aspect was not specifically investigated in this study. In  
479 contrast, optometrists are more focussed on other treatment options, such as *lid hygiene*  
480 and *warmth therapy*. More often than the optometrists, GPs prescribe drops and ointments  
481 with and without preservatives. This goes against the MGD Workshop Report which states  
482 that it is particularly inappropriate and inefficient to use artificial tears with dry eye patients  
483 who have an evaporative aetiology [29].

484

485 While the analyses are not specific enough to make a statement about the behaviour of the  
486 optometrist in managing the dry eye patient, it seems that the optometrist is more focussed  
487 on eyelid disease, such as blepharitis and MGD. Since their “standard” equipment is more  
488 likely to include a slit-lamp and their education towards the anterior segment includes  
489 assessment and diagnosis. In contrast, it appears the GPs approach is more subjective-  
490 based (symptoms) than objective-based (tests). This may reflect the finding that dry eye  
491 investigative techniques are not performed as a standard procedure, which itself may be  
492 due to eye care forming just a small part of their daily work. Such a view is evident from the  
493 high numbers of GPs who do not perform dry eye tests on their patients, and from them  
494 having less knowledge of the recent research of dry eye.

495

496 Overall, the variety in answers given by optometrists in the Netherlands shows a lack of  
497 uniformity in the use of investigative techniques, in the therapeutic options given, and in the  
498 symptoms associated with dry eyes found in their practices. This lack of uniformity was also  
499 observed in the Downie et al. 2013 investigation of Australian optometrists regarding their  
500 use of investigative techniques, management and the use of evidence-based guidelines for  
501 dry eye diagnosis and management [13].

502

503 The need for, and content of, guidelines and plans of management for a health condition is  
504 always a source of debate in all parts of medical practice, and is true also between dry eye  
505 specialists, ophthalmologists, optometrists and cornea specialists [13], [16], [30]. However,

506 the evidence from this study shows that there is a need to establish better management  
507 guidelines for dry eye in the Netherlands that includes GPs, optometrists and  
508 ophthalmologists in a manner beneficial to patient care.

509

### 510 **Limitations**

511 This investigation does have some limitations, primarily from the small percentage of survey  
512 respondents from the total pool, and the difference in numbers of optometrists and GPs  
513 recruited. This might be due to the different recruitment methods used. For the optometrists,  
514 they received an invitation via the optometric board and a known investigator, while the  
515 GPs were sent an email directly by the investigator. Since only GPs with an open access  
516 email address were invited, this could mean that only a selective group was invited.  
517 However, given these limitations, this survey has good internal consistency, with Cronbach  
518 alpha coefficients reported of 0.833 for the GPs and 0.885 for the optometrists (values  
519 range from 0 to 1, with higher values indicating greater reliability). For this kind of survey, a  
520 Cronbach alpha of >0.7 indicates a reliable survey [31]

521

### 522 **Conclusion**

523 The investigation, diagnosis and treatment of dry eye disease vary significantly between  
524 optometrists and GPs in the Netherlands. The optometrists perform more specific tests and  
525 see more dry eye patients per week, but the level of variance in responses between  
526 optometrists indicates that clear guidelines on dry eye management are needed to improve  
527 consistency. GPs rely more strongly on patient symptoms and are less likely to use  
528 alternative treatment methods. These results have implications in the development of  
529 future clinical care pathways for dry eye disease management in the Netherlands.

530

### 531 **Conflict of interest statement**

532 No competing financial interests exist.

533

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537



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