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## Systematic Review

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# Self-Reported Visual Complaints in People with Parkinson's Disease: A Systematic Review

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### Abstract.

**Background:** Scientific research increasingly focuses on visual symptoms of people with Parkinson's disease (PD). However, this mostly involves functional measures, whereas self-reported data are equally important for guiding clinical care.

**Objective:** This review provides an overview of the nature and prevalence of self-reported visual complaints by people with PD, compared to healthy controls.

**Methods:** A systematic literature search was performed. Studies from three databases (PubMed, PsycInfo, and Web of Science) were screened for eligibility. Only studies that reported results of visual self-reports in people with idiopathic PD were included.

**Results:** One hundred and thirty-nine eligible articles were analyzed. Visual complaints ranged from function-related complaints (e.g., blurred vision, double vision, increased sensitivity to light or changes in contrast sensitivity) to activity-related complaints (e.g., difficulty reading, reaching, or driving). Visual complaints were more prevalent in people with PD compared to healthy controls. The presence of visual complaints leads to a reduced quality of life (QoL). Increased prevalence and severity of visual complaints in people with PD are related to longer disease duration, higher disease severity, and off-state.

**Conclusion:** A large proportion of people with PD have visual complaints, which negatively affect QoL. Complaints are diverse in nature, and specific and active questioning by clinicians is advised to foster timely recognition, acknowledgement, and management of these complaints.

Keywords: Activities of daily living, Parkinson's disease, quality of life, self report, systematic review, vision disorders

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## INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disorder characterized by a number of well-known motor and non-motor symptoms, including visual problems [1–5]. During recent years, visual symptoms in PD have received increasing attention in the literature. In clinical practice however, these symptoms are still underrecognized. Visual symptoms are less conspicuous than motor symptoms, and may therefore be overlooked [6, 7]. However, visual symptoms have a substantial impact on the daily lives of people with PD and may already occur in the early and prodromal stages of the disease [1, 4, 8]. Consequently, several studies state the importance of tools to improve the recognition, diagnostic accuracy, and management of non-motor symptoms, including visual symptoms, in clinical practice [2, 9–11].

To date, most tools used to assess visual symptoms are quantitative tests of visual functions. These measurements, in most cases part of an ophthalmological assessment, objectify functions and impairments, such as visual acuity and visual field loss. In contrast, few studies include self-report data, asking people to reflect on their own visual functioning. It is acknowledged that both functional and self-reported data are required to obtain a clear picture of the impact of PD on individuals [9], which is necessary to guide care and rehabilitation [12, 13].

Despite the importance of self-reported data, no reviews have been published on this topic so far. Therefore, this paper presents a systematic review on self-reported visual complaints in PD, compared to healthy controls.

## METHODS

### *Literature search*

A literature search was performed according to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [14]. The search encompassed the scientific databases PsycInfo, PubMed, and Web of Science (Core Collection) and was performed on literature up to the date of February 5, 2021. The search terms are presented in Table 1. Two complementary searches were performed. The first one focused on subjective dysfunction in general, since the current review was part of a project that also examined self-reported cognitive complaints of people with PD. The second search addressed self-reported visual complaints specifically.

### *Eligibility criteria*

Only papers fulfilling the following criteria were included: written in English, published in peer-reviewed academic journals, including human participants with idiopathic PD, including a self-report measure for visual functioning, and data (i.e., prevalence) of this measure for the group of people with PD or a comparison (i.e., prevalence or score) with healthy controls. Visual self-report measures were defined as items, subscales or total scores representing an individual's reflection on their own visual functioning, performance of visual activities or vision-related quality of life (QoL). We made the assumption that a self-report measure was filled out by the patient, unless otherwise stated. Longitudinal or intervention studies were included if relevant baseline measures were presented. Review articles and case reports were excluded, as well as meeting abstracts and letters to editors. Since visual hallucinations in PD are widely recognized and extensively studied [15], these were not incorporated in this review.

### *Literature extraction*

Figure 1 shows the PRISMA outline of papers identified through the literature search. Articles were first screened by title and abstract, and when they seemed relevant, reviewed by the full text. In addition to the database search, reference lists of included papers were screened according to the predefined inclusion criteria. Two authors (IvdL and FH) and a research assistant (EV) systematically judged the eligibility of articles and discussed this in case of doubt. In case uncertainty remained, a third author (GdH) was involved until consensus was reached.

### *Analysis*

Relevant results were extracted from included papers. Results were categorized per complaint. Complaints were divided amongst three categories: function-related complaints, activity-related complaints, and vision-related QoL. Results were ordered based on the number of studies investigating each complaint. Based on this systematic categorization, a descriptive table was included (Table 2). If data on subgroups of PD were reported (e.g., tremor dominant versus akinetic-rigidity subtypes, or young versus late onset PD), but no total prevalence, it was calculated by the authors. The weighted prevalence of a complaint was calculated for studies using the

Table 1  
Search terms for literature search

Search 1	Terms used in all databases	MeSH and thesaurus terms used in PubMed or PsycInfo
First criterion	parkinson <sup>a</sup>	<i>PubMed</i> : "Parkinson Disease"; <i>PsycInfo</i> : "Parkinson's Disease"
Second criterion	"self report", complaint*, "subjective assessment*", "subjective measure*", "subjective problem*", "subjective dysfunction*", "subjective deficit*", "subjective impairment*", "subjective symptom*", "report a problem", "report problem*", "report a dysfunction", "report dysfunction*", "report a deficit", "report deficit*", "report an impairment", "report impairment*", "report a symptom", "report symptom*", "reports a problem", "reports problem*", "reports a dysfunction", "reports dysfunction*", "reports a deficit", "reports deficit*", "reports an impairment", "reports impairment*", "reports a symptom", "reports symptom*", "reported a problem", "reported problem*", "reported a dysfunction", "reported dysfunction*", "reported a deficit", "reported deficit*", "reported an impairment", "reported impairment*", "reported a symptom", "reported symptom*", "perceive a problem", "perceive problem*", "perceive a dysfunction", "perceive dysfunction*", "perceive a deficit", "perceive deficit*", "perceive an impairment", "perceive impairment*", "perceive a symptom", "perceive symptom*", "perceives a problem", "perceives problem*", "perceives a dysfunction", "perceives dysfunction*", "perceives a deficit", "perceives deficit*", "perceives an impairment", "perceives impairment*", "perceives a symptom", "perceives symptom*", "perceived a problem", "perceived problem*", "perceived a dysfunction", "perceived dysfunction*", "perceived a deficit", "perceived deficit*", "perceived an impairment", "perceived impairment*", "perceived a symptom", "perceived symptom*", "experience a problem", "experience problem*", "experience a dysfunction", "experience dysfunction*", "experience a deficit", "experience deficit*", "experience an impairment", "experience impairment*", "experience a symptom", "experience symptom*", "experiences a problem", "experiences dysfunction*", "experiences a deficit", "experiences deficit*", "experiences an impairment", "experiences impairment*", "experiences a symptom", "experiences symptom*", "experienced a problem", "experienced problem*", "experienced a dysfunction", "experienced dysfunction*", "experienced a deficit", "experienced deficit*", "experienced an impairment", "experienced impairment*", "experienced a symptom", "experienced symptom" <sup>a,b</sup>	<i>PubMed</i> : "Self Report"; <i>PsycInfo</i> : "Self Report", "Self-Report"
Search 2	Terms used in all databases	MeSH and thesaurus terms used in PubMed or PsycInfo
First criterion	parkinson <sup>a</sup>	<i>PubMed</i> : "Parkinson Disease"; <i>PsycInfo</i> : "Parkinson's Disease"
Second criterion	questionnaire*, scale*, survey*, inventor*, interview <sup>b</sup>	<i>PubMed</i> : "Surveys and Questionnaires", "Interview, Psychological"; <i>PsycInfo</i> : Questionnaires, Interviews, Surveys, Inventories
Third criterion	seeing OR eyesight OR sight OR ophthalmologic* OR "visual perception" OR "visual acuity" OR "visual field*" OR diplopia OR "double vision" OR "depth perception" OR "color vision" OR "colour vision" OR "color perception" OR "colour perception" OR "contrast sensitivity" OR "visual contrast" OR "brightness perception" OR "light sensitivity" OR "sensitive to light" OR "sensitivity to light" OR "oversensitive to light" OR "oversensitivity to light" OR photophobia OR photosensitivity OR glare OR "dark adaptation" OR "visual overload" OR "problems reading" OR "reading problem*" OR "difficulty reading" OR "reading difficult*" OR "painful eyes" OR "dry eyes" OR "eyelid opening" OR blink* OR "facial recognition" OR "face recognition" OR "face perception" OR "object recognition" OR "object perception" OR "figure perception" OR "form perception" OR "shape perception" OR "motion perception" OR "space perception" OR "spatial perception" OR "spatial orientation" OR "spatial disorientation" OR afterimage* OR "visual discrimination" OR "figure ground discrimination" OR "nonmotor symptom*" OR "non-motor symptom*" OR "autonomic dysfunction*" OR "autonomic symptom*" OR "autonomous dysfunction" OR "autonomous symptom" <sup>a,b</sup>	<i>PubMed</i> : "Visual Perception", "Vision disorders", "Vision screening", "Depth Perception", "Color vision"; <i>PsycInfo</i> : "Visual perception", "Vision disorders", "Diplopia", "Depth perception", "Brightness perception", "Dark adaptation", "Face perception", "Visual acuity", "Visual contrast", "Visual discrimination", "Visual field", "Figure ground discrimination"

<sup>a</sup>Term should be present in title or abstract, <sup>b</sup>One of the terms should be present in the content of the paper.



## PRISMA 2009 Flow Diagram

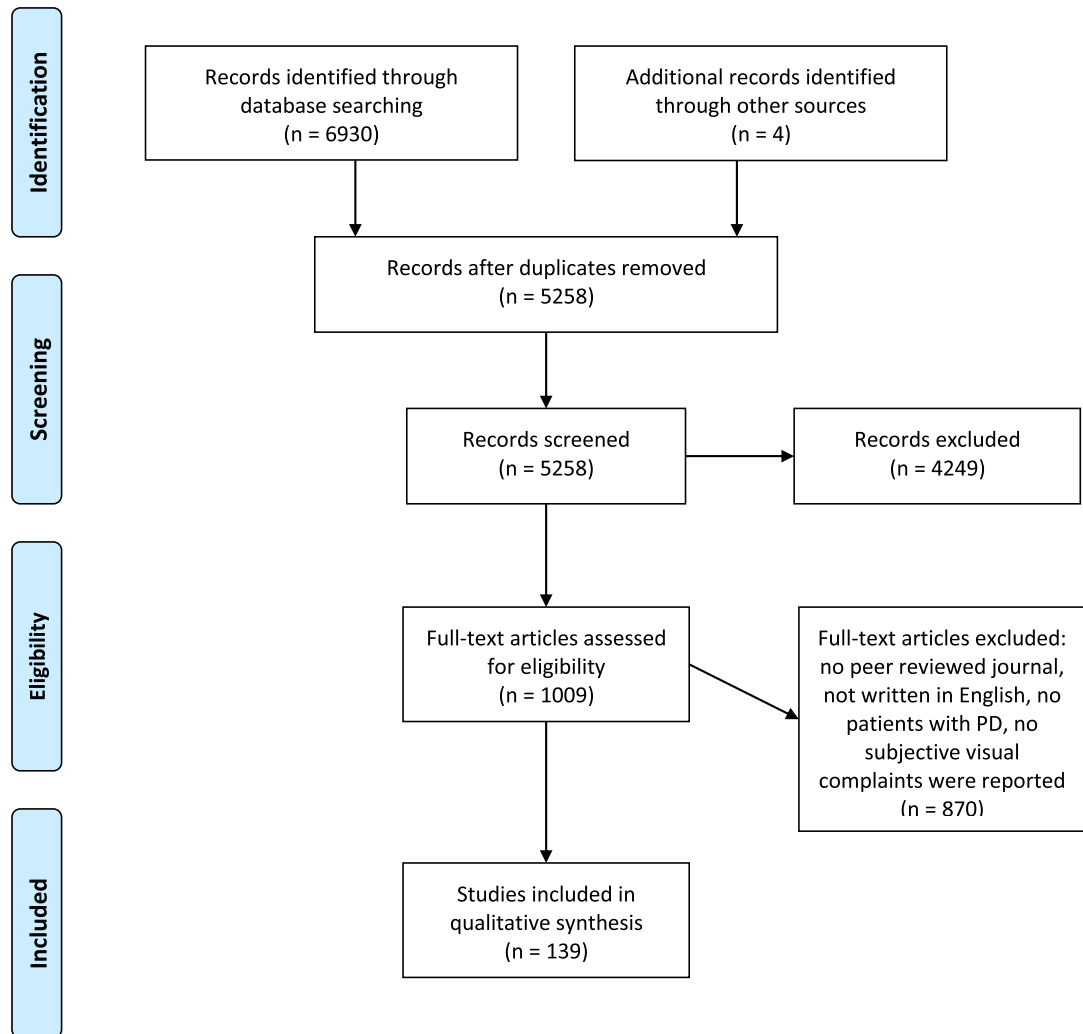


Fig. 1. PRISMA flow diagram of systematic literature search [14].

same method to assess the complaint. Relationships of self-reported visual complaints with demographics and disease-related variables were gathered in an additional table (Table 3).

## RESULTS

The search procedure resulted in 139 relevant articles. Table 2 presents the prevalence of visual complaints reported by people with PD and the comparison with healthy controls. One hundred and thirty-one studies investigated the prevalence of

visual complaints in people with PD. Some studies reported on more than one complaint, resulting in 185 prevalence numbers. Forty-four studies compared the presence of visual complaints between people with PD and healthy controls. Some studies reported group differences for multiple complaints, resulting in 122 numbers on group comparisons. Of these, 102 (83.6%) indicated that people with PD reported more complaints than healthy controls, whilst 20 (16.4%) found either no difference between these groups or reported healthy controls to experience more complaints than people with PD.

Table 2  
Overview of the prevalence of visual complaints in people with PD and the comparison to healthy controls

	Items covering complaint (N)	Criterion presence complaint	Studies (N)	PD patients (N)	Prevalence PD patients (%)	Controls (N)	Prevalence controls (%)	Studies PD > Controls <sup>a</sup> (N)	Studies PD = Controls or PD < Controls <sup>a</sup> (N)
<b>Function-related visual complaints</b>									
Visual complaints in general									
CIRS-G	1	≥1 on a 0 ('no problem') – 4 ('extremely severe') scale	1 [19]	76	98	N/A	N/A	N/A	0
VFQ-25	25	At least one complaint	3 [18, 25, 26]	145	83.1 [25, 26]	466	31.6 [25]	3	0
Direct asking of the patient according to ICF checklist	2	≥1 ('mild difficulty') on a 0 – 4 scale	1 [27]	96	75.5 <sup>b</sup>	N/A	N/A	N/A	N/A
Interview on autonomic dysfunction	4	N/A	1 [20]	26	67	27	22	1	0
Questionnaire on visual complaints (20-item)	N/A	N/A	1 [16]	30	63.3	31	29.0	1	0
PRO-PD	1	≥5 on a 0 ('lack of symptom') – 100 ('maximum severity') scale	1 [32]	1031	58.0	N/A	N/A	N/A	N/A
Self-report questionnaire (31-item)	N/A	At least one complaint	1 [17]	81	78 <sup>c</sup>	N/A	N/A	N/A	N/A
Survey of Health, Ageing, and Retirement in Europe	1	≥4 on a 1 ('excellent') – 5 ('poor') scale	1 [21]	191	46.1	28820	16.1	1	0
Interview using a questionnaire on non-motor symptoms [30]	1	'yes'	2 [22, 30]	76	46.1	N/A	N/A	N/A	N/A
Symptom questionnaire	1	'yes'	1 [28]	39	43.6	N/A	N/A	N/A	N/A
Question: are you bothered due to vision-related problems?	1	N/A	1 [23]	295	41	N/A	N/A	N/A	N/A
Structured interview	N/A	N/A	1 [29]	108	40.7	N/A	N/A	N/A	N/A
Symptom index (20-item)	1	'yes'	1 [31]	61	36.1	N/A	N/A	N/A	N/A
Questions on visual complaints	N/A	N/A	1 [24]	82	26.8	N/A	N/A	N/A	N/A
Double vision									
Questionnaire on changes in vision	1	'sometimes' or 'often'	2 [118, 119]	237	53.1	100	19.0	2	0
Self-report questionnaire (31-item)	1	'sometimes' or 'often'	1 [17]	81	38.0	N/A	N/A	N/A	N/A
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	22	250	3	1	0
Questionnaire derived from VFQ-25	N/A	N/A	2 [25, 116]	178	19.8	122	2.4	2	0
Non-motor fluctuations questionnaire	1	N/A	1 [159]	11	18.2	N/A	N/A	N/A	N/A
NMSQ	1	≥1 ('yes')	61 [33–93]	11511	13.9 <sup>d</sup>	690	3.5 [40, 47, 48, 56, 57, 59, 91, 92]	6 [47, 48, 56, 57, 59, 91]	2 [40, 92]

(Continued)

Table 2  
(Continued)

	Items covering complaint (N)	Criterion presence complaint	Studies (N)	PD patients (N)	Prevalence PD patients (%)	Controls (N)	Prevalence controls (%)	Studies PD > Controls <sup>a</sup> (N)	Studies PD = Controls or PD < Controls <sup>a</sup> (N)
NMSS	1	≥1 ('mild') on a 0 ('none') – 3 ('severe') scale	24 [9, 41, 94–115]	7545	14.2 [9, 41, 94, 96–107, 109–115]	363	2.4 [94, 96]	3 [95, 96, 108]	1 [94]
Online symptom survey	1	'yes'	1 [160]	432	12.7	N/A	N/A	N/A	N/A
Questionnaire on visual complaints (20-item)	N/A	N/A	1 [16]	30	10.0	31	3.2	1	0
Questions on visual complaints	N/A	N/A	1 [24]	82	9.8	N/A	N/A	N/A	N/A
Questions on asthenopia	N/A	N/A	1 [152]	39	7.7	N/A	N/A	N/A	N/A
Increased sensitivity to light			27	6318	15.0 – 48	1480	0 – 28.3	13	2
Interview on autonomic dysfunction	1	N/A	1 [20]	26	48	N/A	N/A	N/A	N/A
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	43	250	23	1	0
ADS (autonomic dysfunction score)	1	N/A	1 [140]	21	38.1	27	0	1	0
SCOPA-AUT	1	≥1 ('sometimes') on a 0 ('never') – 3 ('often') scale	19 [120–138]	5195	31.8 [120, 122, 124–130, 132–138]	1044	28.3 [120, 128–130, 132, 138]	8 [120, 121, 123, 128–130, 132, 138]	1 [131]
COMPASS-31	5	N/A	1 [161]	47	27.7	N/A	N/A	N/A	N/A
Questionnaire derived from VFQ-25	N/A	N/A	1 [25]	88	23.9	90	11.8	1	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [119]	53	15	31	3	1	0
VAQ	3	N/A	1 [142]	25	N/A	23	N/A	0	1
COMPASS	7	N/A	1 [139]	15	N/A	15	N/A	1	0
Altered color vision			9	1394	4.1 – 12.7	894	3 – 10	4	4
Questionnaire on changes in vision	1	'sometimes' or 'often'	2 [118, 119]	237	12.7	100	4.4	1 [118]	1 [119]
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	11	250	3	1	0
Questions on visual complaints	N/A	N/A	1 [24]	82	6.1	N/A	N/A	N/A	N/A
Interview on prodromal symptoms	1	'yes'	2 [141, 143]	145	4.1	145	10	0	2
VFQ-25	1	N/A	2 [18, 26]	57	N/A	376	N/A	2	0
VAQ	3	N/A	1 [142]	25	N/A	23	N/A	0	1

Painful/dry eyes			9	1706	6.1 – 87.5	850	8 – 22.4	5	1
Dry eye symptom assessment	'various'	≥2-3 times a week ('occasionally')	1 [144]	56	87.5	34	20.6	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	28	250	8	1	0
Question on dry eye	1	N/A	1 [162]	43	44.2	N/A	N/A	N/A	N/A
VFQ-25	2	N/A	3 [18, 25, 26]	145	27.3 [25]	466	22.4 [25]	2 [18, 25]	1 [26]
Online symptom survey (dry eyes)	1	'yes'	1 [160]	432	25.7	N/A	N/A	N/A	N/A
Questions on visual complaints	N/A	N/A	1 [24]	82	6.1	N/A	N/A	N/A	N/A
OSDI	12	N/A	1 [145]	100	N/A	100	N/A	1	0
Blurred vision			6	1695	19.7 – 46	630	7.4 – 19.0	4	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	46	250	12	1	0
Symptom questionnaire	1	'yes'	1 [146]	181	36.2	263	19.0	1	0
ADS (autonomic dysfunction score)	1	N/A	1 [140]	21	28.6	27	7.4	1	0
Interview on visual symptoms	1	'yes'	1 [111]	125	20	N/A	N/A	N/A	N/A
Online symptom survey	1	'yes'	1 [160]	432	19.7	N/A	N/A	N/A	N/A
Questionnaire derived from VFQ-25	N/A	N/A	1 [25]	88	N/A	90	N/A	1	0
Changes in contrast sensitivity			3	1157	8.8 – 27	319	10 – 13	2	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [118]	184	27	69	13	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	26	250	10	1	0
Interview on visual symptoms	1	'yes'	1 [111]	125	8.8	N/A	N/A	N/A	N/A
Changes in size and shape perception			3	982	3.7 – 19	281	5 – 13	2	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [119]	53	19 <sup>e</sup>	31	13	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	17	250	5	1	0
Questions on visual complaints	N/A	N/A	1 [24]	82	3.7	N/A	N/A	N/A	N/A
Changes in depth perception			3	926	17 – 26	304	2 – 6	3	1
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [119]	53	26	31	6	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	17	250	2	1	0
VAQ	3	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>
Reduced peripheral vision			3	82	N/A	399	N/A	3	1
VFQ-25	1	N/A	2 [18, 26]	57	N/A	376	N/A	2	0
VAQ	5	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>

(Continued)



Table 2  
(Continued)

	Items covering complaint (N)	Criterion presence complaint	Studies (N)	PD patients (N)	Prevalence PD patients (%)	Controls (N)	Prevalence controls (%)	Studies PD > Controls <sup>a</sup> (N)	Studies PD = Controls or PD < Controls <sup>a</sup> (N)
Difficulty estimating spatial relations			3	390	6.4 – 50	69	28	1	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [118]	184	50	69	28	1	0
Self-report questionnaire (31-item)	1	'sometimes' or 'often'	1 [17]	81	45.0	N/A	N/A	N/A	N/A
Interview on visual symptoms	1	'yes'	1 [111]	125	6.4	N/A	N/A	N/A	N/A
Visual field impairment			2	930	6.1 – 9	250	2	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	9	250	2	1	0
Questions on visual complaints	N/A	N/A	1 [24]	82	6.1	N/A	N/A	N/A	N/A
Watery eyes			2	930	26.8 – 31	250	15	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	31	250	15	1	0
Questions on visual complaints	N/A	N/A	1 [24]	82	26.8	N/A	N/A	N/A	N/A
Changes in motion perception			2	237	23.7	100	3	2	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	2 [118, 119]	237	23.7	100	3	2	0
Reduced night vision			2	869	16 – 47.6	277	3 – 18.5	2	0
ADS (autonomic dysfunction score)	1	N/A	1 [140]	21	47.6	27	18.5	1	0
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	16	250	3	1	0
Reduced light/dark adaptation			2	873	27	273	11	2	1
VIPD-Q	1	≥2 ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	27	250	11	1	0
VAQ	4	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>
Floaters			2	178	N/A	122	N/A	0	2
Questionnaire derived from VFQ-25	N/A	N/A	2 [25, 116]	178	N/A	122	N/A	0	2
Misjudge objects			2	178	N/A	122	N/A	2	0
Questionnaire derived from VFQ-25	N/A	N/A	2 [25, 116]	178	N/A	122	N/A	2	0
Asthenopia (ocular fatigue)			1	39	43.6	39	5.1	1	0
Questions on asthenopia	N/A	Presence of visual discomfort, diplopia, blurred vision or headache when reading	1 [152]	39	43.6	39	5.1	1	0

Hard to follow quick movements with the eyes			1	848	25	250	4	1	0
VIPD-Q	1	$\geq 2$ ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	25	250	4	1	0
Need to turn head to side to see peripheral objects			1	53	43	31	14	1	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [119]	53	43	31	14	1	0
Mucus/slime or particles in eyes or eyelids			1	848	20	250	6	1	0
VIPD-Q	1	$\geq 2$ ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	20	250	6	1	0
Reduced acuity/spatial vision			1	25	N/A	23	N/A	1	1
VAQ	4	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>
Reduced visual processing speed			1	25	N/A	23	N/A	1	1
VAQ	6	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>
Reduced visual search			1	25	N/A	23	N/A	0	1
VAQ	5	N/A	1 [142]	25	N/A	23	N/A	0	1
<b>Activity-related visual complaints</b>									
Reading difficulties			6	1176	18.3 – 42.0	403	5.6 – 9.7	4	0
Self-report questionnaire (31-item)	N/A	N/A	1 [17]	81	42.0	N/A	N/A	N/A	N/A
Questionnaire on visual complaints (20-item)	N/A	N/A	1 [16]	30	26.7	31	9.7	1	0
Questions on asthenopia	N/A	N/A	1 [152]	39	23.1	N/A	N/A	N/A	N/A
VIPD-Q	1	$\geq 2$ ('weekly') on a 0 ('never') – 3 ('daily') scale	1 [117]	848	18.3 <sup>h</sup>	250	5.6 <sup>h</sup>	1	0
Questionnaire derived from VFQ-25	N/A	N/A	2 [25, 116]	178	N/A	122	N/A	2	0
Near activities			5	1875	34.5 – 44.3	114558	9.7 – 25.5	5	0
Survey of Health, Ageing, and Retirement in Europe	1	$\geq 4$ on a 1 ('excellent') – 5 ('poor') scale	1 [21]	1438	44.3	113802	25.5	1	0
CISS	14	$\geq 21$	2 [147, 148]	380	34.5	380	9.7	2	0
VFQ-25	3	N/A	2 [18, 26]	57	N/A	376	N/A	2	0
Difficulty/freezing in narrow spaces			4	415	67.3	222	1.6	4	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	2 [118, 119]	237	67.3 <sup>i</sup>	100	1.6 <sup>i</sup>	2	0
Questionnaire derived from VFQ-25	N/A	N/A	2 [25, 116]	178	N/A	122	N/A	2	0
Distance activities			3	1495	38.6	114178	15.0	3	0
Survey of Health, Ageing, and Retirement in Europe	1	$\geq 4$ on a 1 ('excellent') – 5 ('poor') scale	1 [21]	1438	38.6	113802	15.0	1	0
VFQ-25	3	N/A	2 [18, 26]	57	N/A	376	N/A	2	0

(Continued)

Table 2  
(Continued)

	Items covering complaint (N)	Criterion presence complaint	Studies (N)	PD patients (N)	Prevalence PD patients (%)	Controls (N)	Prevalence controls (%)	Studies PD > Controls <sup>a</sup> (N)	Studies PD = Controls or PD < Controls <sup>a</sup> (N)
Driving			3	94	21.6	355	2.7	3	0
VFQ-25	2	N/A	2 [18, 26]	57	N/A	318	N/A	2	0
Self-report driving questionnaire derived from Charlton et al. (2006) [163]	N/A	'very difficult' in low visibility conditions	1 [149]	37	21.6	37	2.7	1	0
Difficulty reaching for objects			1	184	46	69	3	1	0
Questionnaire on changes in vision	1	'sometimes' or 'often'	1 [118]	184	46	69	3	1	0
Problems with visual ADLs			1	25	N/A	23	N/A	1	1
VAQ	33	N/A	1 [142]	25	N/A	23	N/A	1 <sup>e</sup>	1 <sup>f</sup>
<b>Vision-related QoL</b>									
Vision-specific social functioning			2	57	N/A	376	N/A	2	0
VFQ-25	2	N/A	2 [18, 26]	57	N/A	376	N/A	2	0
Vision-specific role difficulties			2	57	N/A	376	N/A	1	1
VFQ-25	2	N/A	2 [18, 26]	57	N/A	376	N/A	1 [18]	1 [26]
Vision-specific dependency			2	57	N/A	376	N/A	2	0
VFQ-25	3	N/A	2 [18, 26]	57	N/A	376	N/A	2	0
Vision-specific mental health			2	57	N/A	376	N/A	2	0
VFQ-25	4	N/A	2 [18, 26]	57	N/A	376	N/A	2	0

Per complaint, each self-report measure used to describe this complaint is presented individually, along with the number of visual items it includes and the criterion that must be fulfilled for people to belong to the group with visual complaints. Weighted averages (prevalence of visual complaints) are presented for each complaint. References to the studies are placed in brackets []. ADLs, activities of daily living; CIRS-G, Cumulative Illness Rating Scale-Geriatric; CISS, Convergence Insufficiency Symptom Survey; COMPASS, Composite Autonomic Symptom Score; ICF, International Classification of Functioning; N, number/population size; N/A, not available; NMSQ, Non-Motor Symptoms Questionnaire, NMSS = Non-Motor Symptom Scale, OSDI = Ocular Surface Disease Index, PD = Parkinson's disease, PRO-PD = Patient Reported outcomes in Parkinson's Disease; QoL, quality of life; SCOPA-AUT, Scales for Outcomes in Parkinson's disease—autonomic dysfunction; VAQ, Visual Activities Questionnaire; VFQ-25, Visual Function Questionnaire (25-item); VIPD-Q, Visual Impairment in Parkinson's Disease Questionnaire. <sup>a</sup> Difference in score or prevalence between the groups, <sup>b</sup> Weighted prevalence of complaints on the ICF functions 'seeing functions' (72.9%) and 'difficulty with watching' (78.2%), <sup>c</sup> Items that may to some extent have arisen from motor symptoms (e.g., bumping into objects and freezing in narrow spaces) were included in the analysis. Prevalence was 57% after removing these items, <sup>d</sup> Khedr et al. (2012) [90] & Khedr et al. (2013) [55], and Giorelli et al. (2014) [65] & Giorelli et al. (2014) [66] used the same group of people with PD and reported the same results. For this reason, results of only one of these studies was reported, <sup>e</sup> Results only account for the non-tremor group (N = 12), <sup>f</sup> Results only account for the tremor group (N = 13), <sup>g</sup> Weighted prevalence of complaints on size (17%) and shape perception (21%), <sup>h</sup> Weighted prevalence of reading related complaints: 'letters disappear while reading' (20% in patients and 5% in controls) and 'read better with one eye closed' (17% in patients and 6% in controls), <sup>i</sup> Weighted prevalence of the complaints freezing (60% in patients and 3% in controls) and difficulty at doorways (56% in patients and 3% in controls) [119].

Table 3  
Relationship of demographic and disease-related variables with visual complaints

Visual complaint		Significant positive relationship	Significant negative relationship	No significant relationship
<b>Demographic or disease-related variable</b>				
1. Age	Studies ( <i>N</i> )	1	0	3
	Double vision	0	0	2 [66, 111]
	Increased sensitivity to light	0	0	1 [122]
	Reduced visual health status	1 [26]	0	0
2. Gender (+ men > women)	Studies ( <i>N</i> )	1	0	12
	Visual complaints in general	0	0	1 [117]
	Double vision	0	0	10 [34, 50, 66, 67, 72, 75, 97, 103, 105, 111]
	Increased sensitivity to light	0	0	1 [122]
	Altered color vision	1 [17]	0	0
	Difficulty estimating spatial relations	1 [17] <sup>a</sup>	0	0
3. Education	Studies ( <i>N</i> )	0	0	1
	Double vision	0	0	1 [111]
4. Disease duration	Studies ( <i>N</i> )	6	0	3
	Visual complaints in general	2 [32, 117]	0	1 [17]
	Double vision	3 [101, 111, 116]	0	1 [17]
	Increased sensitivity to light	1 [137]	0	1 [122]
	Altered color vision	0	0	1 [17]
	Difficulty estimating spatial relations	0	0	1 [17]
	Asthenopia	0	0	1 [152]
5. Disease severity	Studies ( <i>N</i> )	12	0	6
	Visual complaints in general	0	0	1 [17]
	Double vision	5 [52, 59, 110, 111, 116]	0	2 [17, 66]
	Increased sensitivity to light	4 [120, 132, 138, 151] <sup>b</sup>	0	4 [122, 131, 133, 151] <sup>c</sup>
	Altered color vision	0	0	1 [17]
	Difficulty estimating spatial relations	0	0	1 [17]
	Asthenopia	1 [152]	0	0
	Reduced visual health status	2 [18, 26]	0	0
	Bumping into objects	0	0	1 [17]
6. Motor fluctuations	Studies ( <i>N</i> )	2	0	0
	Double vision	2 [104, 111]	0	0
7. Dominant symptom (+PIGD > tremor dominant)	Studies ( <i>N</i> )	2	0	7
	Double vision	1 [36]	0	6 [50, 55, 66, 81, 93, 96]
	Increased sensitivity to light	0	0	1 [142]
	Altered color vision	0	0	1 [142]
	Changes in depth perception	1 [142]	0	0
	Reduced peripheral vision	0	0	1 [142]
	Reduced light/dark adaptation	1 [142]	0	0
	Reduced acuity/spatial vision	0	0	1 [142]
	Reduced visual processing speed	0	0	1 [142]
	Reduced visual search	0	0	1 [142]
	Problems with visual ADLs	1 [142]	0	0
8. Dyskinesia	Studies ( <i>N</i> )	1	0	0
	Double vision	1 [104]	0	0
9. Left vs. right onset PD	Studies ( <i>N</i> )	0	0	1
	Double vision	0	0	1 [81]
10. Young vs. late onset PD (+late onset > young onset)	Studies ( <i>N</i> )	2	0	2
	Double vision	2 [70, 103] <sup>d</sup>	0	2 [77, 79]
11. Idiopathic PD vs. gene-related parkinsonism (LRRK2 [33], G2385R [161] and PARKIN [79]; +idiopathic PD > gene-related parkinsonism)	Studies ( <i>N</i> )	1	0	3
	Double vision	1 [79] <sup>e</sup>	0	2 [33, 79] <sup>f,g</sup>
	Increased sensitivity to light	0	0	1 [161]
12. Camptocormia	Studies ( <i>N</i> )	1	0	1
	Double vision	1 [114]	0	1 [113]

(Continued)

Table 3  
(Continued)

	Visual complaint	Significant positive relationship	Significant negative relationship	No significant relationship
<b>Medical or surgical treatment</b>				
13. LEDD	Studies ( <i>N</i> )	1	1	5
	Double vision	0	1 [111]	1 [54, 59, 82, 94]
	Reduced visual health status	1 [26]	0	0
	Increased sensitivity to light	0	0	1 [132]
14. Off vs. on state (+ off state > on state)	Studies ( <i>N</i> )	3	0	0
	Visual complaints in general	1 [30]	0	0
	Double vision	1 [111]	0	0
	Problems focusing	1 [119]	0	0
15. Specific medical treatment (Pergolide and Benzhexol [119], and Rotigotine [87, 164])	Studies ( <i>N</i> )	1	0	2
	Double vision	0	0	2 [87, 164]
	Adverse visual effects	1 [119] <sup>h</sup>	0	0
16. DBS (subthalamic nucleus)	Studies ( <i>N</i> )	0	2	0
	Double vision	0	2 [22, 61]	0
<b>Other variables</b>				
17. QoL and ADL	Studies ( <i>N</i> )	0	5	1
	Visual complaints in general	0	1 [117]	0
	Double vision	0	1 [118]	0
	Increased sensitivity to light	0	3 [122, 137, 151]	1 [125]
18. Consultation of medical doctor for eye problem	Studies ( <i>N</i> )	1	0	1
	Bumping into objects	1 [17]	0	0
	Dry eyes	0	0	1 [162]

Supplementary Table 2 provides an overview of investigated relationships per complaint. >, first group reported more visual complaints than second group; ADL, activities of daily living; DBS, Deep Brain Stimulation; LEDD, Levodopa Equivalent Daily Dose; N, number of studies; PIGD, postural instability and gait disorder; QoL, quality of life. <sup>a</sup>Side of onset influenced the relationship of gender with difficulty estimating spatial relations; the difference between males and females was bigger (and significant) for the left onset group than right onset group (not significant), <sup>b</sup>Disease severity measured by Hoehn & Yahr classification and Clinical Impression of Severity Index for Parkinson's Disease (CISI-PD) [151], <sup>c</sup>Disease severity measured by Cumulative Illness Rating Scale – Geriatrics (CIRS-G) [151], <sup>d</sup>Only significant when adjusted for disease duration and dopaminergic treatment duration and dose [70], <sup>e</sup>Result accounts for a group of patients with late onset PD [79], <sup>f</sup>Result accounts for a group of patients with young onset PD [79], <sup>g</sup>Not significant when adjusted for age, gender, disease duration, disease severity, dopamine agonist, and levodopa [33], <sup>h</sup>More colorful dreams were reported after using Pergolide, and relaxation of the eye muscles and blurry vision after using Benzhexol [119].

### Function-related visual complaints

#### Visual complaints in general

Seventeen studies [16–32] reported on visual complaints in general. Six of these studies compared people with PD with a control group. In all cases, the prevalence of visual complaints was higher among patients than among controls [16, 18, 20, 21, 25, 26]. One study examined the number of complaints experienced. Three out of four patients (77.3%) experienced at least one complaint, and 43.2% experienced multiple visual complaints [25]. Only 31.6% of healthy controls reported a visual complaint [25].

#### Double vision

Sixty-one studies reported relevant results on double vision based on the Non-Motor Symptoms Questionnaire (NMSQ) [33–93] and 24 studies based

on the Non-Motor Symptom Scale (NMSS) [9, 41, 94–115] (see Supplementary Figure 1). The prevalence ranged from 2.9% [72] to 23.5% [59] in studies with a sample size  $\geq 150$ . Studies with a smaller sample size ( $N < 150$ ) showed a range from 0% [35, 40, 94] to 60.9% [45]. One study found that for most people with PD experiencing double vision (9.6% of total sample) complaints started after motor symptoms had manifested. Only a small proportion (1.8% of total sample) already experienced double vision before the onset of motor symptoms [71].

Most studies (15/18) on double vision showed a higher prevalence in people with PD compared to controls [16, 25, 47, 48, 56, 57, 59, 91, 95, 96, 108, 116–119]. One study reported prevalence numbers in more detail and showed that 16% of people with PD experienced double vision 'often', and 36% 'sometimes' [118].

### *Increased sensitivity to light*

Nineteen studies included the Scales for Outcomes in Parkinson's disease—autonomic dysfunction (SCOPA-AUT) [120] and reported relevant results for the item on oversensitivity to light in people with PD [120–138]. The prevalence ranged from 1.9% [130] to 61.0% [120] (see Supplementary Figure 2). Most studies (13/15) showed that the prevalence was higher in people with PD compared to controls [25, 117, 119–121, 123, 128–130, 132, 138–140].

Other light-related complaints were more prevalent in people with PD as well. People with PD had significantly more difficulty adapting to changing light conditions than controls (patients: 27% vs. controls: 11%) [117], and experienced reduced night vision more often (patients: 16% – 47.6% vs. controls: 3% – 18.5% [117, 140]).

### *Altered color vision*

Prevalence of altered color vision did not significantly differ between people with PD and healthy controls in the majority of studies [18, 26, 118, 119, 141–143]. Three studies indicated a trend toward more complaints among people with PD [18, 26, 118]. Only one study found that significantly more people with PD (11%) reported the perception of colors to be more pale than controls did (3%) [117]. Another study found that 10% of people with PD perceived less color than before, while 5% perceived more color [118].

### *Painful, dry or watery eyes*

Complaints related to painful, dry or watery eyes were more frequently reported by people with PD than by controls (5/6 studies [18, 25, 117, 144, 145]). Also, severity seems to differ. People with PD had 'moderate dry eye disease' and controls 'mild dry eye disease' [145]. It was reported that 28% of people with PD had a burning sensation or gritty feeling in their eyes, and only 8% of controls [117]. While some studies could not confirm significance [25, 26], painful eyes were present in 27.3% of people with PD compared to 22.4% of controls [25]. Watery eyes were more frequently reported by people with PD (26.8% – 31%) than controls (15%) [24, 117].

### *Blurred vision*

The prevalence of blurry vision was higher in people with PD compared to healthy controls (4/4 studies [25, 117, 140, 146]). Patients experiencing blurry vision indicated that their vision was worse in

the dark and they needed more light to see clearly [119].

### *Changes in contrast sensitivity*

Changes in contrast sensitivity were more often reported by people with PD compared to controls (2/2 studies [117, 118]). Roughly a quarter of people with PD (27%) reported changes in the perception of contrast (23% perceived less contrast, 4% perceived more contrast) [118]. People with PD (26%) reported more difficulty reading plain text on a colored or gray background compared to controls (10%) [117].

### *Changes in size, shape, or depth perception*

People with PD reported more complaints regarding size, shape, or depth perception than controls [117, 119]. Seventeen percent of people with PD experienced difficulty with size, shape, and depth perception, compared to 2% (depth) – 5% (size/shape) of controls [117].

### *Peripheral vision*

People with PD experienced significantly more limitations in peripheral vision (i.e., 'noticing objects off to the side') than controls [18, 26]. People with PD (43%) indicated to need to turn their head to the side to see peripheral objects more often than controls did (14%) [119].

### *Difficulty estimating spatial relations*

Half of the patients (50%) reported misjudging spaces (5% 'often' and 45% 'sometimes'), compared to 28% of controls [118]. Most people with PD (27%) indicated that spaces appear smaller, while 17% noted that spaces seem larger.

### *Visual field impairment*

People with PD experienced visual field impairments more often (6.1% [24] – 9% [117]) than healthy controls (2% [117]).

### *Changes in motion perception*

Changes in motion perception were reported by a significantly higher number of people with PD (19% – 25%) than controls (3%) [118, 119]. Eight percent of people with PD had difficulties 'often', and 17% 'sometimes'. Most people with PD perceived motion as faster (13%), while few perceived motion to be slower (4%). Others perceived motion to be less smooth (3%) [118]. In addition, people with PD had more difficulty following quick movements with their eyes (patients: 25% vs. controls: 4%) [117].

### Activity-related visual complaints

#### Reading difficulties

People with PD reported more difficulty reading than controls (4/4 studies [16, 25, 116, 117]). While one study could not confirm significance, a higher prevalence was found in people with PD (26.7%) compared to controls (9.7%) [16]. Compared to controls, people with PD reported significantly more often that letters disappeared while reading (patients: 20% vs. controls: 5%) and that they had fewer reading difficulties when having one eye closed while reading (patients: 17% vs. controls: 6%) [117].

#### Near and distant visual activities

People with PD reported more problems with near (patients: 44.3% vs. controls: 25.5%) and distant visual activities (patients: 38.6% vs. controls: 15.0%) than controls [21]. All five studies confirmed this result [18, 21, 26, 147, 148]. Most individuals who had difficulty working nearby reported that their eyes felt tired or uncomfortable [147, 148]. In contrast, people with PD 'often' do not have trouble judging close (95%) or distant objects (87%), comparable to healthy controls, of which 96% and 99% did not have problems judging close or distant objects, respectively [118].

#### Difficulty/freezing in narrow spaces

People with PD had more difficulty in narrow spaces than controls (4/4 studies [25, 116, 118, 119]). Walking through narrow spaces was difficult for 70% of people with PD, compared to 1% of controls [118]. Eighteen percent of people with PD indicated to have difficulties 'often', and 52% 'sometimes'. People with PD indicated to freeze (26%), bump (29%), feel uneasy (10%), or have other problems (3%) while walking through narrow spaces.

Freezing (patients: 60% vs. controls: 3%) and difficulty at doorways (patients: 56% vs. controls: 3%) was also significantly more common in people with PD compared to controls [119]. Half of the people with PD reported to bump into objects [17].

#### Driving

People with PD experienced more driving difficulties compared to controls (3/3 studies [18, 26, 149]). This could be attributed to poor vision, especially at night. Along with that, people with PD reported difficulties with reading maps or using navigational devices [17]. Besides finding driving more difficult in low visibility conditions (patients: 21.6%

vs. controls: 2.7%), people with PD avoid these situations more frequently compared to controls (patients: 35.1% vs. controls: 5.4%) [149].

#### Difficulty reaching for objects

People with PD reported significantly more difficulty reaching for objects (46%) than controls (3%). Nine percent of people with PD had difficulties 'often', and 37% 'sometimes'. Most patients indicated to not reach far enough (27%), while others reached too far (7%) or reached off to one side of the object (8%) [118].

#### Vision-related QoL

People with PD scored significantly worse than controls on vision-related QoL (Visual Function Questionnaire; VFQ [150]) [18, 26]. Social functioning and mental health are influenced, role difficulties exist, and people with PD are more dependent on others due to their visual problems. Except for role difficulties, vision-related QoL was influenced to a greater extent in people with PD than in controls.

#### Relationship of demographic or disease-related variables with visual complaints

Table 3 reports on the relationship of demographic and disease-related characteristics with self-reported visual complaints. Visual complaints did not relate to age (3/4 studies [66, 111, 122]) and gender (12/13 studies [34, 50, 66, 67, 72, 75, 97, 103, 105, 111, 117, 122]). Most studies did find a relationship with disease duration (6/9 studies [32, 101, 111, 116, 117, 137]) and severity (12/18 studies [18, 26, 52, 59, 110, 111, 116, 120, 132, 138, 151, 152]), indicating that visual complaints were more prevalent in patients with a longer disease duration and a more severe disease. Dominant symptoms of the disease (7/9 studies [50, 55, 66, 81, 93, 96, 142]), as well as side of onset (1/1 study [81]) did not relate to visual complaints.

A higher Levodopa Equivalent Daily Dose (LEDD) was not related to visual complaints (5/7 studies [54, 59, 82, 94, 132]), while patients did report more complaints during off-state (3/3 studies [30, 111, 119]). Some medicaments (i.e., Pergolide and Benhexol) led to visual adverse effect (1/1 study [119]). Deep Brain Stimulation (DBS) was found to relieve double vision (2/2 studies [22, 61]).

The relationship of visual complaints with objectified visual disorders and non-motor symptoms was also investigated (see Supplementary Table 1).

Double vision was related to abnormal ocular alignment and aberrant movements of the eyes [116]. Regarding painful or dry eyes, decreased tear production, abnormalities in Meibomian glands, and ocular surface problems could confirm the complaint [16, 145], but it was not related to decreased tear film break-up time or tear osmolarity [145]. Visual complaints were not related to cognitive functioning (3/4 studies [102, 111, 151]), but it did co-occur with psychotic symptoms (e.g., hallucinations; 3/3 studies [24, 111, 151]).

Visual complaints were found to negatively relate to the performance of activities of daily living (ADL) and QoL (5/6 studies [117, 118, 122, 137, 151]).

Supplementary Table 2 presents an overview of investigated relationships with demographic and disease-related variables per visual complaint (an aid for understanding Table 3 and Supplementary Table 1).

## DISCUSSION

This systematic review aimed to provide an overview of the literature on self-reported visual complaints in people with PD. Visual complaints occur in a wide variety in people with PD. Moreover, there is a fundamental difference between people with PD and healthy controls. More than 80% of comparisons showed that visual complaints were more common in people with PD than in controls.

According to the literature found, the prevalence of visual complaints varies greatly. Nevertheless, we can conclude that visual complaints were more often present in people with PD than in controls. Visual complaints in general appear to occur in at least a quarter of people with PD, with prevalence ranging from 26.8% – 98%. Other complaints with a relatively high prevalence are blurred vision (19.7% – 46%), watery eyes (26.8% – 31%), light-related complaints (reduced night vision (16% – 47.6%) and light/dark adaptation (27%)), ocular fatigue (43.6%), and all activity related complaints (>21.6%; i.e., reading, driving, reaching, near or distant activities, and difficulty/freezing in narrow spaces). Complaints that appear less prevalent are altered color vision (4.1% – 12.7%), and visual field deficits (6.1% – 9%).

Vision-related QoL in people with PD appears to be affected in a variety of ways. This is not surprising given that vision is essential in performing a wide variety of activities. Moreover, people with PD need their vision to compensate for their motor

loss [6]. Therefore, vision loss may lead to even more difficulties in daily life.

### *Strengths and limitations*

We conducted a systematic literature search and selected all articles that met the inclusion criteria. By involving at least three researchers in the process of data extraction, we sought to ensure reliable and standardized data extraction.

We aimed at providing a comprehensive overview of the literature on self-reported visual complaints in PD. The inclusion of lower quality studies may have biased the results. The prevalence of a complaint was sometimes determined by only few studies and small sample sizes (e.g., asthenopia prevalence was determined in 39 patients [152]). Moreover, the studies used different methods, response options and criteria to assess the complaints in patient groups with different disease characteristics. Therefore, the results presented should be interpreted with caution and results cannot be directly compared. For example, the two lowest rates of double vision are found in de novo PD patients [72, 94], which is in line with the reported increase of visual complaints with disease duration and severity (see Table 3). Also, it was not always clear in the phrasing of questions that problems were attributed to vision [17, 118, 119]. People might have involved other symptoms when answering the questions (i.e., reading difficulties were attributed to both visual problems and difficulties with concentration [17]). For the sake of transparency, we listed the (number of) references, the number of participants in whom a complaint was investigated, and the criterion on which the prevalence was based.

Some visual complaints are reported relatively often, while there are also complaints that are hardly ever reported. An important explanation for this is that former complaints are addressed in frequently used self-reports or questionnaires, while the latter are not. This does not mean that visual complaints not included in those instruments are less common or should be taken less seriously. The majority of 139 included studies ( $N=85$ , 61.2%) reported double vision, an item in the NMSS and NMSQ. Similarly, oversensitivity to light constitutes an item in the SCOPA-AUT and was therefore reported in multiple studies ( $N=19$ , 13.7%). Only 35 articles (25.2%) investigated visual complaints using other measures. For example, only few studies asked for experienced visual field loss or reduced contrast sensitivity, which might nevertheless be relevant in the light of known



visual field and contrast sensitivity deficits in PD [4, 153]. To obtain a more complete picture of the prevalence, nature, and severity of visual complaints in people with PD and the characteristics of people who experience these complaints, future research should systematically examine a broad range of visual complaints in a large group of people with PD.

### *Clinical implications*

Detection of visual complaints is necessary to prevent unnecessary limitations in QoL. With knowledge of the visual complaints a patient experiences, clinicians are able to select treatments based on the patient's priorities [12, 154]. In addition, the use of self-report measures within rehabilitation may provide insight into the changes a patient is experiencing and can indicate when individual goals have been achieved [13].

Visual complaints may be an indication of a treatable underlying disorder, which requires assessment and treatment by an ophthalmologist. Complaints may also relate to underlying disorders that cannot be treated, in which case vision-related rehabilitation may be recommended. As an example, complaints of double vision may be caused by cataract, ptosis, or corneal surface abnormalities. These conditions may be treated with cataract extraction, surgery, or artificial tears, respectively. Another possible cause of double vision is convergence insufficiency, which may require prism glasses or advice on how to compensate while reading.

In some cases, objectified functional disorders may not fully reflect self-reported complaints. For example, even though color vision deficits are more common in people with PD compared to controls [155, 156], people with PD do not tend to report more complaints with regard to color vision. In this example, treatment seems irrelevant because patients do not suffer from the underlying disorder. Therefore, care should always be based on self-reported complaints as well.

Although the literature is scarce, visual complaints seem to be related to disease duration and severity. In addition, visual complaints might be influenced by certain types of treatment. Therefore, we suggest that people with PD should be questioned more frequently and more thoroughly about these complaints in clinical practice, especially in advanced disease stages or with medication changes.

The importance of active questioning is also evident from the fact that visual problems might not

always be spontaneously reported to healthcare professionals [48, 49], given that people with PD and their family members are often unaware of the relationship between visual complaints and PD [50]. In addition, Martinez-Martin et al. (2007) argued that these complaints may not be recognized unless detected by a questionnaire [60]. Recently developed visual self-report questionnaires may be used to improve the visual care for people with PD [157, 158].

### *Conclusion*

This overview illustrates that a substantial number of people with PD report complaints in a variety of visual domains. These complaints are related to disease duration and severity and may be influenced by medication use. Since visual complaints have a clear negative impact on QoL, attention to and management of these complaints is essential. Active questioning is advised for timely recognition and treatment of visual complaints.

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### **CONFLICT OF INTEREST**

The authors have no conflict of interest to report.

### **SUPPLEMENTARY MATERIAL**

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