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Review article

Patient-reported outcomes in patients with vitreous floaters: A systematic literature review

Jarinne E. Woudstra-de Jong, MSc [a,b,*], *Sonia S. Manning-Charalampidou, MD(Res)* [a,c], *Hans Vingerling, MD PhD* [d], *Jan J. Busschbach, PhD* [b], *Konrad Pesudovs, PhD* [e]

[a] *Rotterdam Ophthalmic Institute, Eye Hospital Rotterdam, Rotterdam, the Netherlands*
[b] *Department of Psychiatry, Section Medical Psychology and Psychotherapy, Erasmus Medical Centre, Rotterdam, the Netherlands*
[c] *Department of Vitreoretinal Surgery, Eye Hospital Rotterdam, Rotterdam, the Netherlands*
[d] *Department of Ophthalmology, Erasmus Medical Centre, Rotterdam, the Netherlands*
[e] *School of Optometry and Vision Science, Medicine & Health, University of New South Wales, Sydney, New South Wales, Australia*

ARTICLE INFO

Article history:
Received 6 February 2023
Revised 6 June 2023
Accepted 6 June 2023
Available online 12 June 2023

Keywords:
Vitreous
Floaters
Patient-reported outcome measures
Assessment
Quality of life
Visual functioning
Psychosocial health

ABSTRACT

Seeking treatment for bothersome vitreous floaters is patient driven. To measure the impact of floaters and treatment on an individual's quality of life, patient-reported outcome measurements (PROMs) are essential. We review all studies using a PROM for patients with floaters. We evaluated content coverage against quality-of-life domains previously identified in other ophthalmic disorders, and against a qualitative study investigating quality-of-life issues in patients with floaters. We assessed measurement properties of PROMs using an extensive range of psychometric quality criteria. We identified 59 studies using 28 different PROMs. Many PROMs were not specifically developed for patients with floaters. Floater-specific PROMs were mostly based on content validation from an ophthalmologist or researcher perspective; two included a patient perspective. Using the outcomes of the qualitative study, we found that the floater-specific PROMs were narrow in their content coverage, with most items relating to visual symptoms and activity limitations. Testing the psychometric quality of PROMs was rare, and when employed mostly limited to responsiveness and known group validity. The remarkable high number of floater-specific PROMs reveals a need for such measurements in ophthalmology. Unfortunately, reporting on psychometric quality is limited, and content development is most often done without patient involvement.

* Corresponding author: Jarinne E. Woudstra de Jong, MSc, P.O. Box 70030, 3000 LM Rotterdam, the Netherlands.
E-mail address: j.dejong@oogziekenhuis.nl (J.E. Woudstra-de Jong).

https://doi.org/10.1016/j.survophthal.2023.06.003

1. Introduction

The burden of vitreous floaters varies enormously from individual to individual. Ophthalmologists find it difficult to decide whether to intervene or not, based only on visual acuity and symptoms. Knowing the impact of floaters on an individual's quality of life (QoL) will help with this decision. QoL is measured with patient-reported outcome measures (PROMs). We review all existing PROMs used for patients with floaters, assessing them against accepted quality criteria.

2. Terminology and brief background

Vitreous floaters, opacities in the vitreous body of the eye, are a common visual complaint.[1,16] The majority of vitreous floaters are caused by age-related vitreous syneresis, or liquification of the vitreous. Less frequently, vitreous floaters are a manifestation of posterior or panuveitis and may be accompanied by other symptoms that have an impact on QoL.[56] In this review, we focus on floaters caused by age-related vitreous syneresis. Floaters appear to patients as mobile opacities in their visual field.[68] Many people perceive floaters, with self-reported prevalence levels reaching 76%.[77,88] Interestingly, not everyone who experiences floaters is bothered by them.[77] Some patients objectively have many and/or large floaters in the vitreous, but without an impact on QoL. Other patients have floaters that debilitate their everyday life and impact their well-being.[69] Quantifying this impact, studies found that patients who present themselves to an ophthalmologist with a chief complaint of floaters were willing to trade 7–11% of their remaining life years to get rid of the symptoms.[61,86,95] These findings demonstrate that seeking treatment for floaters is driven by patient motivation.[83] As ophthalmologists must weigh the possible complications of surgical intervention against the benefit of alleviating floater symptoms, a wait-and-see policy is often adopted where patients need to accept and adapt to symptoms caused by floaters.[10,73] This experience can be frustrating to patients who suffer from their floaters.[67] To make the decision whether to intervene or not for each specific patient depends upon the impact of floaters on a patient's life; thus, adequately measuring QoL is important.

Clinical measures are not a very useful measures of the experience of floaters and their impact on QoL. The severity of floaters and efficacy of treatment options for floaters is evaluated, both in research and clinical practice, using clinical measures such as imaging and visual acuity; however, floaters are not always objectifiable by imaging and often do not affect visual acuity.[21,36,44,58,G] For this reason, researchers have incorporated PROMs in their studies for floaters, such as subjective improvement and satisfaction rates.[3,10,12,31,36,72,87,B] Interestingly, there is a frequent mismatch between objective improvement and subjective improvement,[47,70,71] i.e., satisfied patients do not always have increased visual acuity, and vice versa. Thus, depending solely on clinical parameters and measures is inadequate and does not fully reflect the impact of floaters on QoL,[11,58] highlighting the need for solid PROMs in research and clinical management of floaters.

Floaters affect different aspects of QoL. In one qualitative study by Cipoletta and coworkers, 11 patients with floaters were interviewed to investigate their experiences.[6] Most patients described the floaters as a nuisance. Some patients worried, some did not, which depended on the experience or perception of the disease and personal explanations about the nature or cause of floaters. Several patients noted how floaters limited their lives and ability to work, invalidated personal roles, and caused a loss in the meaning of life, resulting in depressive symptoms or anger. The reaction of patients upon perceiving floaters differed: from ignoring or accepting them to worrying or actively searching for solutions - which, according to the authors, depended on how people use resources in times of need and their trust placed in medicine. As QoL is a multidimensional concept, and floaters can affect multiple dimensions, this should be reflected in the content of measurements assessing QoL.

To adequately measure the experienced effect of floaters on QoL, PROMs should have good psychometric quality, i.e., good measurement properties, and their content should be relevant to patients.[4,8,11,15,25,27,49,78] Unfortunately, PROMs in ophthalmology often lack psychometric quality, have not been validated for use in specific eye disorders, and are limited in content - mostly measuring activity limitations and not representing other relevant QoL domains.[4,11,27,49,53,55,93] We suspect this is also true for PROMs for patients with vitreous floaters, but no systematic reviews on this topic exist. One systematic review[55] assessed the content and psychometric quality of PROMs in retinal diseases until 2014, where vitreous floaters are listed under "mixed retinal diseases," only including two papers on patients with floaters.[6,9] Another systematic review from 2021[69] investigated the psychological impact of floaters, using QoL as a search term but not PROMs, again missing relevant papers. The current paper is the first systematic literature review on PROMs for patients with vitreous floaters, assessing the psychometric quality and content of every questionnaire, and providing an overview of items (questions) used in PROMs.

3. Methods

An overview of the literature search is provided in Section VII, "Method of Literature Search."

We grouped studies using PROMs according to the type of PROM used: developed specifically for floaters (floater-specific PROMs), multiple eye disorders (ophthalmic PROMs), one specific QoL issue (generic single-domain PROMs), or multiple domains across diseases (generic multi-domain PROMs). First, we extracted all PROM items and identified their content, grouping items into QoL domains that were established in other eye disorders: activity limitation, mobility, visual, ocular, and general symptoms, emotional and social well-being, economic impact, conveniences, health concerns, coping, general vision, and difficulty with different lighting conditions.[14,25,26,41,54] To assess the relevance and broadness of the content of PROMs, we compared the content of the items to QoL issues described in Cipoletta and coworkers.[6]

Subsequently, we assessed all PROMs on six different groups of established quality criteria: content development,

psychometric properties based on Classical Test Theory and/or Rasch analysis, validity, reliability, and responsiveness.[8,35,49,52,53,55,57,78,85] The criteria are defined in detail in Table 1. We graded each PROM on all quality criteria using three levels: high (A), acceptable (B), or poor quality (C).

4. Results

The literature search resulted in 273 records after removing duplicates (Fig. 1). We excluded 227 records after reading the abstracts. We added 14 records from citation and reference searching,[90] resulting in a total of 60 included records. We identified one qualitative study[6] and 59 studies using one or more PROMs (Table 2): one ophthalmic PROM in 28 records,[5,9,18,19,33,34,37,39,44,46,47,61–63,65,66,70,71,74,76,D,E,G-I,M-O] 5 generic single-domain PROMs used in 12 records,[13,18,22,24,28,29,43,79,81,89,91,92] one generic multi-domain PROM in one record,[23] and 20 different floater-specific PROMs in 25 records.[2,21,29,32,33,40,60,62,64,70,71,77,82,88,94,C,D,F,G,J-L,P-R] Eighteen records included a single floater-specific PROM item.[3,5,10,31,33,34,36,40,48,70–72,74,76,81,87,E,F] We identified the content coverage of floater-specific PROMs (Appendix 1) and assessed the psychometric quality (Table 3) of all PROMs.

4.1. Ophthalmic PROM: NEI VFQ

The most-often used PROM in studies on patients with floaters was the National Eye Institute Visual Function Questionnaire (NEI VFQ),[38] either with additional items (NEI VFQ-39)[18,39,46,61,63,65,66,N,O] or without additional items (NEI VFQ-25),[5,19,33,34,37,44,47,62,70,71,74,76,D,E,G,H,M] or a modified version.[9] Other ophthalmic PROMs exist,[15] but so far only the NEI VFQ is used in studies on floaters. It should be noted here that selecting an PROM solely based on its popularity overlooks several problems.[27] For instance, the NEI VFQ, is widely used but nevertheless has serious flaws when used in a population of patients with floaters, as we will show below. Its use should therefore be carefully considered, or better avoided, as good results on the NEI VFQ may not related to good QoL of the patients with floaters and vice versa.

First, the content of the NEI VFQ is narrow and not tailored to patients with vitreous floaters. The NEI VFQ consists of items on activity limitations, e.g., difficulty in reading, driving, and watching television, or socio-emotional well-being, e.g., visiting people, worrying, and feeling frustrated and dependent. In its construction, patients with different ophthalmic disorders were consulted, but not patients with floaters resulting from age-related vitreous syneresis.[38] Some of its content, therefore, is irrelevant to these patients: not measuring floater-specific visual symptoms and the impact of different lighting conditions (found in several floater-specific PROMs), nor problems with coping (found in the qualitative study[6]). Likewise, the NEI VFQ has items about ocular symptoms, which were not mentioned in any of the other PROMs or in the qualitative study. The irrelevance of some NEI VFQ items is reflected in the responsiveness patterns: the subscales of color vision and ocular pain were not responsive in any of the 28 studies. Several authors tried to make the NEI VFQ more floater specific by adapting it,[9,D,R] or by adding single PROM items to it[5,33,34,48,70,71,74,76,E]; for example, the modified version by De Nie and coworkers[9] added an item about "being bothered by floaters"; however, the psychometric quality of these modified PROMs remains unclear.

Regarding psychometric quality, the measurement properties of the NEI VFQ have been extensively analyzed in other ophthalmic conditions, e.g., cataract.[50] Looking at the use of the NEI VFQ in floater patients, the NEI VFQ's psychometric properties are unclear - with mixed results on validity and responsiveness, and no information on reliability. One Rasch analysis found proof for unidimensionality and acceptable item fit statistics.[33] The other studies used summary scoring, with known limitations compared to interval scoring.[51] The NEI VFQ had mixed known group validity when comparing participants with and without floaters (poor[33,O] and good[46,70,71]). Several studies found good concurrent validity with contrast sensitivity,[37] reading speed,[61] and infrared fundus photography.[75] Most studies found acceptable responsiveness when comparing sum scores before and after treatment,[5,33,34,44,61–63,65,66,70,71,74,76,N] except one.[46] There were no reports on reliability. All in all, despite its frequent use, the irrelevant content and unclear psychometric quality make the NEI VFQ a suboptimal measure of QoL for patients with floaters.

4.2. Generic PROMs

Several authors used an existing generic PROM, with one or multiple domains, to quantify the disease burden of floaters. None of these PROMs have been developed specifically for patients with vitreous floaters or other ophthalmic conditions. We found one study using a generic multi-domain PROM: the Dartmouth Cooperative Functional Health Assessment (COOP) charts,[23] and 5 generic single-domain PROMs used for patients with floaters: the State-Trait Anxiety Inventory (STAI)[74] assessing anxiety[18,29]; the Perceived Stress Scale (PSS)[7] assessing stress[29]; the Center of Epidemiological Studies - Depression (CES-D)[59] scale and Patient Health Questionnaire (PHQ-9)[30] assessing depression[29,91]; and Visual Analog Pain Scales (VAPS) to measure ocular pain during anesthesia injections, during surgery, or after surgery.[13,22,24,28,43,79,81,89,92] All studies used sum scoring.

Some of the generic PROMs could discriminate between people who perceive floaters from people who do not, i.e., good-known group validity, showing higher scores of depression, anxiety, and stress in patients with floaters.[23,29,91] The VAPS had good acceptability in one study.[22] The STAI had acceptable responsiveness.[18] However, generic PROMs lack disease-specific items, such as visual symptoms, limiting their ability to measure the full impact of floaters on QoL. Additionally, generic PROMs are often less sensitive and responsive to discriminate small differences in specific disease trajectories[42]; but as most studies did not assess responsiveness of generic PROMs in patients with floaters, we cannot assess whether this statement holds for generic versus floater-specific PROMs.

4.3. Floater-specific PROMs

Instead of using an existing PROM, many authors constructed their own floater-specific PROM or single PROM items, or used

Table 1 – Quality assessment criteria used to assess PROMs.[8,35,52,57,78,85]

Property	Definition	Level	Quality criteria
Content development			
Item identification	The identification process of the initial item content.	A	Comprehensive consultation with patients using qualitative interviews or focus groups and literature review for that particular disease group.
		B	Minimal consultation with patients and literature review.
		C	No consultation with patients/Developed for other disease group.
Item selection	The selection process of the items included in the final PROM.	A	Pilot instrument was developed and tested with Rasch analysis or factor analysis; Items with floor and ceiling effects were removed; Missing data were considered; Statistical justification is given for selecting and reducing items.
		B	Only some of these techniques were used.
		C	No pilot instrument was developed; No statistical justification of selecting items were provided.
Classic Test Theory-based psychometric properties			
Acceptability	The percentage of people for whom scores can be computed, i.e., no missing data.	A	The percentage of missing data for majority of items ≤ 5%.
		B	The percentage of missing data for majority of items > 5% to ≤ 40%.
		C	The percentage of missing data for majority of items > 40%.
Targeting of the items	The extent to which scores span across the entire range of response options, i.e., no floor or ceiling effects.	A	End-point responses (either floor or ceiling effect) ≤ 5% for majority of items.
		B	End-point responses (either floor or ceiling effect) > 5% to ≤ 40% for majority of items.
		C	End-point responses (either floor or ceiling effect) > 40% for majority of items.
Internal consistency	The extent to which all items measure the same latent variable, measured from pairwise correlations between items.	A	Cronbach's alpha (α) ≥ 0.7 to ≤ 0.95.
		B	α ≥ 0.6 to ≤ 0.7, or > 0.95.
		C	α < 0.6.
Rasch-based psychometric properties			
Response categories	The extent to which response categories are chosen in a logical and evenly spaced order.	A	Ordered response categories; Gap between adjacent category thresholds ≥ 0.5 logit.
		B	Ordered response categories with narrow gaps between adjacent category thresholds (< 0.5 logit) or ordering of categories was obtained by repairing disordered categories.
		C	Unrepairable disordered categories.
Dimensionality	The extent to which the PROM measures a single underlying construct, measured by Principal Component Analysis of residuals (PCA_{res}).	A	PCA_{res}: Variance explained by the measure ≥ 60% or eigenvalue of the first contrast < 2.0. If eigenvalue ≥ 2.0, disattenuated correlation between the person measures > 0.7.
		B	PCA_{res}: Variance explained by the measure ≥ 50% to < 60% or disattenuated correlation between the person measures on the two item clusters > 0.57 to ≤ 0.7.
		C	PCA_{res}: Variance explained by the measure < 50% or disattenuated correlation between the person measures on the two item clusters ≤ 0.57, indicating multidimensionality.
Measurement precision	The extent to which the PROM distinguishes between different levels of participant's abilities.	A	Person separation index (PSI) ≥ 2.50; Cronbach's alpha (α) ≥ 0.85.
		B	PSI ≥ 2.0 to < 2.50; α ≥ 0.80 to < 0.85.
		C	PSI < 2.0; α < 0.80.
Item fit statistics	The extent to which the items fit with the expected values from the Rasch model.	A	All items with infit and outfit mean squares > 0.7 to ≤ 1.3.
		B	Most items within > 0.7 to ≤ 1.3 and one or two items within > 0.5 to ≤ 1.5 limit.
		C	More than two items within or one or two items outside > 0.5 to ≤ 1.5 limit.

(continued on next page)

Table 1 – (continued)

Property	Definition	Level	Quality criteria
Differential item functioning (DIF)	The extent to which response ability levels of different subgroups of the same population differ on items.	A	All items with DIF contrast ≤ 0.50 logit (P value < 0.05) for al DIF assessments between group factors, such as age, gender, and language.
		B	Some items with DIF contrast > 0.50 to ≤ 1.0 logits (P value < 0.05) and DIF contrast for one item > 1.0 logit (P value < 0.05).
		C	More than one item DIF contrast > 1.0 logit (P value < 0.05).
Local item dependency		A	Residual inter-item correlations < 0.3.
		B	Residual inter-item correlations ≥ 0.3 to < 0.6.
		C	Residual inter-item correlations ≥ 0.6.
Targeting	The extent to which the item difficulty (item means) matches with the level of visual abilities (person means).	A	Difference between item and person means ≤ 1 logit.
		B	Difference between item and person means > 1 to ≤ 2 logits.
		C	Difference between item and person means > 2 logits.
Validity			
Concurrent validity	The extent to which the PROM correlates to clinical measures of visual functioning.	A	Tested against appropriate measure with correlation ≥ 0.3 to < 0.9.
		B	Tested against debatable measure with correlation ≥ 0.3 to < 0.9.
		C	Correlation < 0.3 or > 0.9.
Convergent validity	The extent to which the PROM correlates to other instruments that measure quality of life.	A	Tested against appropriate measure with correlation ≥ 0.3 to < 0.9.
		B	Tested against debatable measure with correlation ≥ 0.3 to < 0.9.
		C	Correlation < 0.3 or > 0.9.
Discriminant validity	The extent to which the PROM correlates to other instruments that do not measure quality of life.	A	Tested against appropriate measure with correlation < 0.3.
		B	Tested against debatable measure with correlation < 0.3.
		C	Correlation ≥ 0.3.
Known group validity	The extent to which the PROM distinguishes between clinically distinct groups.	A	Tested between appropriate clinical groups with significant difference between groups.
		B	Tested in debatable clinical groups with significant difference between groups.
		C	Insignificant difference between groups.
Reliability and responsiveness			
Test-retest reliability	The extent to which the PROM is temporally stable when administered at two different times.	A	Intra-class correlation (ICC) ≥ 0.8.
		B	ICC > 0.60 to < 0.8.
		C	ICC < 0.60.
Intermodal agreement	The extent to which the PROM performs similarly with two different modes of delivery, e.g., pen-and-paper or digital.	A	Limits of agreement (LOA) < minimally important difference (MID), or weighted kappa ≥ 0.8, or intermodal correlation ≥ 0.7.
		B	LOA > MID (but close), or weighted kappa > 0.6 to < 0.7, or intermodal correlation > 0.5 to < 0.7.
		C	LOA > MID, or weighted kappa < 0.6, or intermodal correlation < 0.5, or incorrect statistical test, or inadequate sample (n < 30).
Responsiveness	The ability of the PROM to detect clinically relevant changes over time.	A	Change in score shown > MID, or change with intervention, or effect size ≥ 1, or responsiveness statistics given.
		B	Change in score shown, but relationship to MID not reported, or effect size ≥ 0.5 to < 1.
		C	Change in score shown < MID, or effect size < 0.5.

PROM = patient-reported outcome measurement.

one from other authors. We identified twenty different floater-specific PROMs: the Eye Floater Questionnaire,[G] Floater Disturbance Questionnaire,[2] Frankfurt Floater Questionnaire,[D,R] Floater Prevalence Survey,[88] Short Floater Questionnaire,[77,J] Visual Function Questionnaire,[62] a modified Visual Quality of Life Questionnaire,[21] 3 different PROMs all named the Vitreous Floaters Symptom Questionnaire,[29,33,Q] and 10 unnamed floater-specific PROMs.[32,40,60,64,70,71,82,94,C,F,K,L,P]

The floater-specific PROMs consisted mostly of items on activity limitation, visual symptoms, and difficulty with

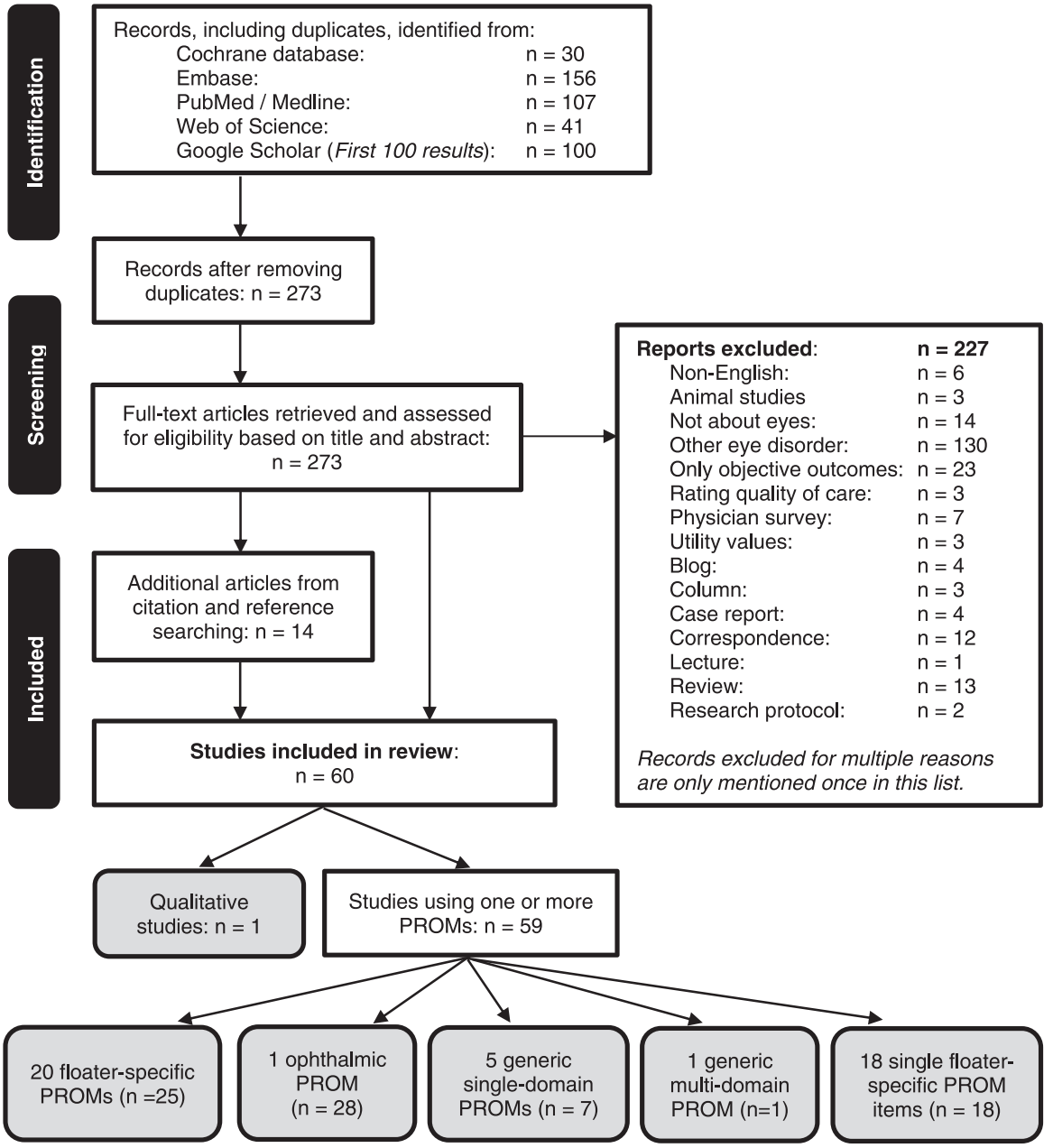

Figure 1 – Identification, screening, and inclusion of records for this systematic literature review.

lighting conditions, with 32%, 29%, and 8%, respectively, of the total of floater-specific PROM items. The activity limitation items mostly related to reading (in 8 PROMs) and driving (in 7 PROMs). Eleven PROMs had items on visual symptoms, mainly on experiencing floaters. The lighting conditions items in 4 PROMs covered being dazzled by bright light, noticing floaters more in bright light, and having to use sunglasses. There is a large overlap in content when looking at the QoL domains described in Cipoletta and colleagues[6] and the content of floater-specific PROMs (Table 4); however, the interviews also highlighted some issues that were missed in the disease-specific PROMs: concerns about the cause of floaters, wanting an explanation for them, how paying attention made them more visible, and the many ways patients coped with the floaters. So there seems to be a mismatch between the outcome of the qualitative study and the choice of the items for the disease-specific PROMs.

There was no information reported on the psychometric quality of 7 PROMs, or the authors could not provide us with this information.[60,62,77,82,88,94,J,L] Three studies explicitly report on content development: Hahn and colleagues[21] consulted patients and ophthalmologists on their adaptation of the Visual Quality of Life Questionnaire[17]; The Eye Floater Questionnaire was developed by a patient organization for floaters[67,G]; and Koch and colleagues[D,R] used two existing PROMs as a basis for the Frankfurt Floater Questionnaire, combining the Wellbeing Index from the World Health Organization (WHO-5)[80] and several items from an ophthalmic

Table 2 – Studies using a patient-reported outcome measure for patients with floaters.

First author (year)	Country (N)	Sample description	Name of instrument	Type of PROM
Ankamah (2021)[2]	Ireland (61)	Dietary supplement	Floater Disturbance Questionnaire	Floater-specific
Bessa (2019)[3]	Egypt (68)	Nd:YAG laser	Single item	Floater-specific
Cañote (2020)[5]	Peru (20)	Nd:YAG laser	National Eye Institute Visual Function Questionnaire-25 (NEI VFQ-25)	Ophthalmic
			Single item	Floater-specific
De Nie (2013)[9]	Netherlands (107)	Nd:YAG laser	Modified NEI VFQ	Ophthalmic
Delaney (2002)[10]	UK (31)	Nd:YAG laser	Unnamed instrument	Floater-specific
			Single item	Floater-specific
Fan (2021)[13]	China (30)	Vitrectomy	Visual Analog Pain Scale (VAPS)	Generic
García (2021)[18]	Spain (34)	Nd:YAG laser	National Eye Institute Visual Function Questionnaire-39 (NEI VFQ-39)	Ophthalmic
			State-Trait Anxiety Inventory (STAI)	Generic
Goh (2022)[19]	Malaysia (12)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
Hahn (2018)[21]	Germany (64)	Vitrectomy	Visual Quality of Life Questionnaire	Floater-specific
Haider (2020)[22]	Pakistan (*)	Vitrectomy	VAPS	Generic
Hayasaka (2006)[23]	Japan (23)	Before treatment	Dartmouth Cooperative Functional Health Assessment (COOP) charts	Generic
Inouye (2021)[P]	USA (32)	Nd:YAG laser	Unnamed instrument	Floater-specific
Jeroudi (2018)[24]	USA (7)	Vitrectomy	VAPS	Generic
Kim (2008)[28]	USA (1)	Vitrectomy	VAPS	Generic
Kim (2017)[29]	South Korea (61)	Before treatment	Vitreous Floaters Symptom Questionnaire (version 1)	Floater-specific
			Patient Health Questionnaire (PHQ-9)	Generic
			Perceived Stress Scale (PSS)	Generic
			STAI	Generic
Koch (2014)[D,R]	Germany (102)	Vitrectomy	NEI VFQ-25	Ophthalmic
			Frankfurt Floater Questionnaire	Floater-specific
Lam (2017)[31]	China (50)	Vitrectomy	Single item	Floater-specific
Lin (2016)[32]	China (15)	Vitrectomy	Unnamed instrument, same as Mason[40]	Floater-specific
Lin (2022)[33]	China (51)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Vitreous Floaters Symptoms Questionnaire (version 2)	Floater-specific
			Single item	Floater-specific
Ludwig (2021)[34]	Brazil (21)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Single item	Floater-specific
Luo (2018)[36]	China (30)	Nd:YAG laser	Single item	Floater-specific
Ma (2019)[E]	China (91)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Single item	Floater-specific
Mamou (2015)[37]	USA (22)	Before treatment	NEI VFQ-25	Ophthalmic
Martínez-Sanz (2009)[39]	Spain (7)	Vitrectomy	NEI VFQ-39	Ophthalmic
Mason (2014)[40,F]	USA (127)	Vitrectomy	Unnamed instrument	Floater-specific
			Single item	Floater-specific
Nagpal (2013)[43]	India (1)	Vitrectomy	VAPS	Generic
Navarro (2015)[44]	Brazil (8)	Vitrectomy	NEI VFQ-25	Ophthalmic
Nguyen (2019)[46]	USA (97)	Nd:YAG laser	NEI VFQ-39	Ophthalmic
Nguyen (2022)[47]	USA (12)	Vitrectomy	NEI VFQ-39	Ophthalmic
Nguyen-Cuu (2017)[G]	USA (17)	Before treatment	NEI VFQ-25	Ophthalmic
			Eye Floater Questionnaire	Floater-specific
Nguyen-Cuu (2018)[D]	USA (32)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
Nunes (2021)[48]	Brazil (24)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Single item	Floater-specific
Osmancevic (2019)[Q]	Croatia (10)	Nd:YAG laser	Vitreous Floaters Symptom Questionnaire (version 3)	Floater-specific
Rao (2022)[60]	Pakistan (50)	Vitrectomy	Unnamed instrument	Floater-specific
Rostami (2019)[61]	USA (67)	Vitrectomy	NEI VFQ-39	Ophthalmic
Ruiz (2013)[J]	Belgium (191)	General public	Short Floater Questionnaire	Floater-specific
Ryan (2020)[62]	USA (20)	Vitrectomy	NEI VFQ-25	Ophthalmic
Schiff (2000)[63]	USA (5)	Vitrectomy	NEI VFQ-39	
			Visual Function Questionnaire	Floater-specific
Schulz-Key (2011)[64]	Sweden (49)	Vitrectomy	Unnamed instrument	Floater-specific
Sebag (2014)[65]	USA (61)	Vitrectomy	NEI VFQ-39	Ophthalmic

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Table 2 – (continued)

First author (year)	Country (N)	Sample description	Name of instrument	Type of PROM
Sebag (2018)[66]	USA (145)	Vitrectomy	NEI VFQ-39	Ophthalmic
Shah (2017, 2020)[70,71]	USA (52)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Unnamed instrument, same as Delaney[10]	Floater-specific
			Single item	Floater-specific
Singh (2015)[72]	USA (198)	Nd:YAG laser	Single item	Floater-specific
Souza (2020)[74]	Brazil (32)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Single item	Floater-specific
Sun (2019)[76]	China (55)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
			Single item	Floater-specific
Tassignon (2016)[77]	Belgium (182)	General public	Short Floater Questionnaire	Floater-specific
Theocharis (2007)[79]	Sweden (1)	Vitrectomy	VAPS	Generic
Trujillo-Sanchez (2018)[81]	Mexico (30)	Vitrectomy	VAPS	Generic
			Single item	Floater-specific
Tsai (1993)[82]	China (15)	Nd:YAG laser	Unnamed instrument	Floater-specific
von Fricken (2009)[L]	USA (35)	Vitrectomy	Unnamed instrument	Floater-specific
Wanni (2018)[M]	Malaysia (3)	Nd:YAG laser	NEI VFQ-25	Ophthalmic
Waseem (2021)[87]	USA (51)	Vitrectomy	Single item	Floater-specific
Webb (2013)[88]	USA (603)	General public	Floater Prevalence Survey	Floater-specific
Wickham (2009)[89]	UK (*)	Vitrectomy	VAPS	Generic
Wu (2020)[91]	China (39)	Vitrectomy	Center of Epidemiological Studies - Depression scale (CES-D)	Generic
Wu (2018)[92]	China (30)	Vitrectomy	VAPS	Generic
Yee (2017)[O]	USA (28)	Vitrectomy	NEI VFQ-39	Ophthalmic
Yee (2013)[N]	USA (38)	Vitrectomy	NEI VFQ-39	Ophthalmic
Zeydanli (2020)[94]	International (568)	Vitrectomy	Unnamed instrument	Floater-specific

PROM = patient-reported outcome measurement.
* For Haider[22] and Wickham[89]: Sample size not reported.

PROM (the NEI VFQ),[38] and adding floater-specific items. The Vitreous Floaters Symptoms Questionnaire by Lin and colleagues[33] is the only floater-specific PROM where Rasch-based psychometric properties were assessed; they found good item fit and unidimensionality. Other PROMs were assessed using properties from Classical Test Theory; however, we could not apply most of the psychometric quality criteria because of a lack of reported information. When information was reported, studies found good acceptability,[2,29,62,Q] poor targeting[2,29,64,P] or acceptable targeting,[Q] good validity,[10,29,G,Q] and acceptable responsiveness.[2,10,21,33,Q] There were no reports on reliability.

4.4. *Single floater-specific PROM items*

Fourteen studies used a single floater-specific PROM item: a rating of the severity of floaters, visual disturbance, inconvenience caused by floaters, or discomfort during surgery.[3,5,10,31,33,36,40,48,70,74,76,81,87,E] When reported, the acceptability of the items was good, i.e., no missing data.[3,10,34] Three studies used a single PROM item to compare people suffering from floaters to people without floaters; they found mixed known group validity (poor[34] and high[70,71]). When comparing the answers over time, PROMs had acceptable responsiveness.[48,70,71,74] Most single items are poorly targeted and show floor and ceiling effects,[3,10,31,33,36,40,48,72,87] except in 2 studies[34,76]; the answers to these items are skewed towards "very severe symptoms" before treatment and towards "very significant improvement in symptoms" after treatment, meaning the single items could not discriminate well between people.

5. Discussion

Seeking treatment for bothersome vitreous floaters is patient driven.[69] Therefore, PROMs are essential to measure the impact on QoL in clinical management and research of floaters. In this systematic literature review, we set out to explore the different PROMs used for patients with floaters, and to give an overview of their content and psychometric quality. We found 28 different PROMs used for patients with floaters and several single PROM items. There is a remarkable high number of floater-specific PROMs (21) developed for patients with floaters, revealing a need for such measurements in ophthalmology. Importantly, as this review shows, reporting on psychometric quality of PROMs is limited, content development is most often done without patient involvement, and the PROMs do not measure the full impact of floaters on QoL.

When assessing and selecting a PROM, one of the most important aspects is the relevance and breadth of its content. A PROM should have good content validity, i.e., its content should be comprehensive, relevant, and representative of all aspects of QoL,[8,57,78] in our case QoL related to floaters. Most PROMs, however, were developed without patient consultation, omitting a necessary condition for content development.[8,11,15,78] Looking at the list of items from floater-specific PROMs, the items arguably touch on most relevant QoL domains: activity limitations and mobility problems, a variety

Table 3 – Assessment of psychometric quality of patient-reported outcome measures (PROMs) used for patients with vitreous floaters.

Patient-reported outcome instruments	Content development		Classical test theory-based properties			Rasch-based psychometric properties							Validity				Reliability and responsiveness		
	II	IS	AC	TA	IC	RC	DI	MP	IF	DF	LD	TR	CC	CV	DV	KV	RR	IA	RE
Floater-specific PROMs and single items																			
Eye Floater Questionnaire[G]	B												A	A					
Floater Disturbance Questionnaire[2]			A	C											A				B
Frankfurt Floater Questionnaire[D,R]	C																		
Vitreous Floaters Symptom Questionnaire (version 1)[29]	C	B					A		A										B
Vitreous Floaters Symptom Questionnaire (version 2)[33]			A	C												A			
Vitreous Floaters Symptom Questionnaire (version 3)[Q]	C		A	B											A				B
Visual Quality of Life Questionnaire[21]	B	C																	B
Unnamed instrument used in Delaney[10] and in Shah[70,71]															A	A			B
Unnamed instrument used in Clerici[C]																			B
Unnamed instrument used in Inouye[P]			A	C															
Unnamed instrument used in Mason[40,F] and in Lin[32]																			B
Unnamed instrument used in Schulz-Key[64]				C															
Single items[3,10,31,33,36,40,48,72,74,76,87,E]			A	A/C												A			B
Ophthalmic PROM (National Eye Institute-Visual Function Questionnaire)																			
NEI VFQ-25[5,19,33,34,37,44,47,62,70,71,74,76,D,E,G,H,M]	C	C	A										A/B	A		A			B/C
NEI VFQ-39[18,39,46,60,62,64,65,N,O]	C	C														A/C			B/C
Modified NE-VFQ by De Nie[9]			A	C															
Generic PROMs (single or multiple domains)																			
Center of Epidemiological Studies - Depression scale (CES-D)[91]																A			
Darthmouth Cooperative Functional Health Assessment (COOP) charts[23]																A			
State-Trait Anxiety Inventory (STAI)[18,29]																B			
Patient Health Questionnaire (PHQ-9)[29]																A			
Perceived Stress Scale (PSS)[29]																A			
Visual Analog Pain Scale (VAPS)[13,22,24,28,43,79,81,89,92]			A																

Psychometric quality criteria: II = Idem identification; IS = Item selection; AC = Acceptability; TA = Targeting (classic test theory-based); IC = Internal consistency; RC = Response categories; DI = Dimensionality; MP = Measurement precision; IF = Item fit statistics; DF = Differential item functioning; LD = Local item dependency; TR = Targeting (Rasch-based); CC = Concurrent validity; CV = Convergent validity; DV = Discriminant validity; KV = Known group validity; RR = Test-retest reliability; IA = Intermodal agreement; RE = Responsiveness.
Quality assessment: A = Good quality; B = Acceptable quality; C = Poor Quality, Mixed results ('A/B', 'A/C', or 'B/C'); None = Not reported.
No information reported for: Floater Prevalence Survey,[88] Visual Function Questionnaire,[62] Short Floater Questionnaire,[77,J] 4 unnamed instruments [60,82,94,L] and 2 single items.[5,81]

Table 4 – Overlap between items in patient-reported outcome measures (PROMs) and quality-of-life (QoL) issues in the qualitative study by Cipoletta and colleagues.[6]

QoL domains	Items in floater-specific PROMs	QoL issues in Cipoletta and colleagues[6]
Activity limitation	Driving, Reading, Using the computer, Watching television, Exercise, Household activities	Stopping with hobbies
Convenience	General inconvenience, Surgery	-
Coping	-	Ignoring, Accepting, Searching for the solution, Contact with other patients, Confiding in others, Contacting multiple health care providers
Economic impact	Ability to work	Quitting or being fired from work
Emotional well-being	Frustration, Good mood	Anger, Anxiety, Depressive symptoms, Loss of meaning in life
Environmental factors	Difficulty with different lighting conditions	-
General health	Overall health	Importance of a good overall health
General vision	Visual discomfort, Quality of vision	Nuisance
Health concerns	Worse vision	The cause of the problem, Going blind
Mobility	Walking	-
Ocular symptoms	Pain before or during surgery, Discomfort	Absence of ocular pain or discomfort
Social well-being	Conversations	Responsibilities, Ability to fulfill roles, Feeling like a burden
Visual symptoms	Appearance, Laterality, Severity, Duration, Frequency	Appearance, Transient (having to pay attention) or continuous, Duration

of symptoms, health concerns, inconveniences, the impact on emotional and social well-being, the economic impact, different coping strategies, and difficulty with different lighting conditions; but none of the PROMs included items on all domains. More importantly, a PROM that includes items from different QoL domains does not automatically provide valid measurements of each domain. In other words, choosing a PROM with a large variety of items does not equal high content validity, as multiple validated items are needed to enable measurement of a domain. Content validity should be assessed against QoL domains established in qualitative studies. Unfortunately, qualitative information on patient's experiences of floaters are sparse, and the results of our study suggest a mismatch between the outcome of the single qualitative study and choice of the items for the disease-specific PROMs. As an important drawback of the single qualitative study, also noted by the authors,[6] is that only 11 patients were interviewed, which is too few to reach content saturation.[20] In other words, the qualitative study likely does not exhaust all potential content and misses QoL issues because not enough patients were interviewed in the study. A comprehensive qualitative study, including a sufficient number of patients, is needed to investigate the full impact of floaters on all domains of QoL in depth. This information can be used to refine existing floater-specific PROMs and inform future initiatives of PROM development.

As a second, and important, aspect of assessing and selecting a PROM for patients with floaters, the PROM should be validated and have good psychometric quality in a population with floaters. Unfortunately, in the vast majority of cases, there are no reports on psychometric quality, and where reports on psychometric quality exist, they are incomplete. Some records only included an abstract, limiting the amount of information on content and psychometric quality for several floater-specific PROMs.[A,C,G,K,L] In general, there is not enough information reported to assess psychometric quality of most PROMs, prohibiting us from choosing the best available PROM to use for patients with floaters. Notably, PROMs that are not tested, or where not enough information is reported about psychometrical testing, are not necessarily flawed, but simply untested.[27] We have mostly focused on the content development of PROMs. The fact remains that a PROM can never have good psychometric quality if the content is irrelevant to patients.

The issues with content and psychometric quality of current PROMs are not limited to the floater literature. Many PROMs in ophthalmology only measure vision-related activity limitations.[11] One systematic review on PROMs in retinal diseases found limited content coverage – most only measured activity limitations – and poor psychometric quality of disease-specific PROMs.[55] None of the PROMs were validated for use in any retinal disease, except one for age-related macular degeneration, and only a few studies used Rasch analysis. Likewise, PROMs used for patients with floaters are limited in content coverage and not validated specifically for use in floaters. In our review, only one study uses Rasch analysis.[33] That is unfortunate, as Rasch analysis is a more advanced psychometric method than Classical Test Theory, and provides interval scoring and additional insights in the psychometric performance of PROMs. Rasch analysis is also a key step for delivering the PROM to patients via computerized adaptive testing (CAT). A new generation of PROMs in ophthalmology uses CAT based on Rasch analysis,[25,51] developing item banks with patient consultation to assure that the psychometric quality is state-of-the-art.[52] Delivery of a well-developed and validated questionnaire via CAT has several advantages: it makes PROMs shorter, more accurate, and more relevant to the patient.[15] In other words, using CAT is more efficient, while keeping a good level of measurement precision. Unfortunately, no such PROM exists for patients with floaters.

6. Conclusion and recommendations

This is the first systematic literature review to assess PROMs for patients with vitreous floaters. We provide an overview of

PROMs used for patients with floaters and the QoL domains that are considered relevant in the current literature. The items in these PROMs capture what the authors, often researchers and/or ophthalmologists, deem important to patients with floaters. Notably, additional QoL issues arise when patients themselves are consulted through interviews.[6] Although some PROMs are popular in studying QoL in patients with floaters, such as the NEI VFQ, these PROMs miss content validity and cannot pick up QoL in floaters in a relevant way. Interestingly, despite lacking content validity, most studies found acceptable responsiveness when comparing NEI VFQ sum scores before and after treatment. Content validity is to some level present in disease-specific PROMs developed for patients with floaters; however, although there are disease-specific questionnaires developed for patients with floaters, we could unfortunately not establish whether these instruments are sufficiently valid in this population, as psychometric properties were insufficiently documented. That means that, on the basis of this literature review, we cannot recommend any of the instruments discussed. Clinicians and researchers that want to choose a PROM for patients with floaters should beware that all current PROMs are narrow in content and have not been validated properly. A comprehensive and scientifically solid floater-specific PROM is needed, based on content development with patient and expert consultation and a thorough validation processes to establish its psychometric properties. Because of the absence of a reliable and valid PROM with the appropriate content for patients with floaters, the development of a new PROM can be justified.[49]

7. Methods of literature search

We searched PubMed (Medline), Embase, Web of Science, the Cochrane Database, and Google Scholar using the search terms: floaters, mouches volantes, vitreous opacities, or myodesopsia, and QoL, experience, subjective, interview, focus group, questionnaire, instrument, patient-reported outcome, or patient-reported outcome measure. The literature search dates September 12, 2022. Two of the authors [J.W.J. and S.M.C.] independently assessed the records for inclusion. We resolved disagreements regarding inclusion through discussion with all authors. Exclusion criteria were papers with a non-English abstract, animal studies, papers about another eye disorder or imaging of the eyes, case reports, correspondence, editorials, reviews, and studies that only used objective outcomes, utility values, patient ratings on satisfaction with care, or physician surveys. For 8 records, only information from the abstract was available.[A-C,G,I-M]

8. Disclosures

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

Funding

This work was supported by the Netherlands Organisation for Health Research and Development (ZonMW) (grant number 60-64400-98-210); Stichting Wetenschappelijk Onderzoek Het Oogziekenhuis (grant number 2021S05); Rotterdamse Stichting Blindenbelangen (grant number B20220001); and Stichting Ooglijders (grant number 2021-09). The funding sources had no involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

CRediT authorship contribution statement

JEWdJ: Literature search, Writing – original draft, Visualization. **SSMC**: Conceptualization, Literature search, Writing – review & editing. **HV**: Writing – review & editing. **KP**: Methodology, Writing – review & editing. **JJB**: Writing – review & editing.

Key references

Key references are marked as Asterisk in the Reference list

a. To inform clinicians, researchers, and PROM developers, qualitative studies investigating the impact of a condition on QoL are necessary. For this review, we found one such paper by Cipoletta et al[6] covering interviews with 11 patients with vitreous floaters.
b. The review from Senra et al[69] investigates the psychological impact of vitreous floaters – highlighting the impact of floaters and different outcomes to measure this impact: coping, well-being, mental health, and quality of life.
c. Our review follows similar methods as Prem Senthil et al,[55] who investigated the quality and content of PROMs in retinal diseases, including two records on patients with floaters.
d. PROMs should have good measurement properties and relevant content. Khadka et al[25] have described the methodology of developing PROMs using CAT in ophthalmology, with a literature review of current PROMs as a first step.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.survophthal.2023.06.003.

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X.A. Other Cited Material

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X.A.3. Professional journals

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