·Investigation·

Prevalence of vitreous floaters in a community sample of smartphone users

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Abstract

• AIM: To estimate the prevalence and risk factors for vitreous floaters in the general population.

• METHODS: An electronic survey was administered through a smartphone app asking various demographic and health questions, including whether users experience floaters in their field of vision. Multivariate logistic regression analysis was used to determine risk factors.

• RESULTS: A total of 603 individuals completed the survey, with 76% reporting that they see floaters, and 33% reporting that floaters caused noticeable impairment in vision. Myopes were 3.5 times more likely (P=0.0004), and hyperopes 4.4 times more likely (P=0.0069) to report moderate to severe floaters compared to those with normal vision. Floater prevalence was not significantly affected by respondent age, race, gender, and eye color.

• CONCLUSION: Vitreous floaters were found to be a very common phenomenon in this non-clinical general population sample, and more likely to be impairing in myopes and hyperopes.

• KEYWORDS: vitreous floaters; myopia; survey; floaters; age

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INTRODUCTION

Most cases of vitreous floaters in the mammalian eye are thought to arise from two causes; the introduction of exogenous material during hemorrhage or inflammation, and degenerative molecular rearrangements of vitreous collagen fibrils that results in localized aggregations[1,2]. Both forms of floaters are capable of scattering light entering the eye, and are often described by the patient as spots, shadows, cobwebs, and other assorted shapes that seem to move about in the field of vision. They are thought to be more common starting in the third decade of life, but nonetheless are a very common complaint from all ages presenting to eye clinics [3]. Most cases of floaters are considered benign, but many patients nonetheless complain that floaters greatly affect their quality of life[4].

For the most part, floaters are treated conservatively with reassurance of the patient; however, more severe cases have been treated with Nd:YAG vitreolysis and pars plana vitrectomy. These treatment methods have shown mixed success. Laser therapy has shown a good safety profile but has had limited effectiveness in published work [5]. Vitrectomy has been shown to be very effective in reducing floaters, and is generally considered safe but may have a higher incidence of side effects than laser therapy[5-8].

Relatively little is known about why particular individuals develop floaters. Some cases are associated with specific mechanical events such as retinal breaks and posterior vitreous detachment (PVD)[9,10]. Myopia appears to increase the likelihood of PVD, and floaters have been anecdotally reported to be common in myopes[4], perhaps secondary to the link between myopia and early PVD [11]. The relative risk for floaters conferred by myopia or other biophysical characteristics, however, remains to be established.

Despite numerous anecdotal complaints about floaters in clinics and on patient-run websites, no studies that we are aware of have formally assessed their prevalence in the general population. Smartphones are becoming widely used, and represent a promising method for surveying epidemiological characteristics of community populations. In this study, we employed a smartphone-based survey to assess the prevalence of vitreous floaters in a non-clinical, community sample.

SUBJECTS AND METHODS

Survey After obtaining university institutional review board

approval, an anonymous, confidential survey was developed as a smartphone application, freely available for download and use on Android smartphones for those 18 years of age and older. A total of 1 098 respondents initiated the survey, and of these, 603 usable responses were obtained, which we defined as those who answered question items regarding whether they saw floaters, and answered questions about their vision status (*i.e.*, whether they were emmetropes, myopes, or hyperopes). Those not answering these questions or giving a response of 'unknown' were excluded from the analysis.

The survey consisted of multiple-choice and free-form questions, and respondents were asked demographic questions about their age, gender, and race. They were also asked health questions about whether they were nearsighted, farsighted, or had normal vision, and if they had ever experienced a significant eye injury, LASIK surgery, or were diagnosed with diabetes, or glaucoma.

To assess the prevalence of vitreous floaters, users were asked, "Have you ever noticed things that look like specks, squiggly lines, or dark spots that seem to float around in your vision? They are usually noticed when squinting and looking at a bright background like the blue sky or a bright, white computer screen." They were also shown a photo simulation of how floaters might appear in the vision against a blue sky background. Users who indicated 'yes' to seeing floaters were then asked "on a scale of 1-5, how bothersome are these floaters?" Users were able to select a severity response between 1 through 5, with text descriptions at some severity items. A response of "not at all" was scored 1; a response of "They are annoying, but don't interfere with being able to see things" was scored 3, and "They are a serious problem, making it hard to see" was scored 5.

Recruitment Recruitment bias is a clear concern with a self-selected survey. To minimize recruitment bias towards those with floaters participating in this web-based study, we constructed the survey to specifically eliminate keyword searches directly related to floaters, and instead described the app as a more general eye survey. By doing so, users searching for an app related to floaters or for eye disease would not locate this survey. To retroactively examine whether recruitment bias towards floaters was likely, we were able to examine user search results once the study was complete. The Android app market, in which the survey was hosted, allows analysis of what users are searching for when downloading a certain app, giving an estimation of original user intent in finding it. The twenty most common app searches and related downloads for users viewing this app were for graphics editing software, followed by apps pertaining to music, illusion entertainment, and one app about color blindness. These choices suggested that users were, in general, not specifically searching for keywords related to eye health or floaters, and were thus not likely to be specifically seeking out an app for eye problems. Because common conditions that potentially affect vision (*e.g.*, diabetes, eye injury, glaucoma, and LASIK surgery) may potentially affect floater prevalence, users were queried about whether they had these health conditions. Our analysis of co-morbid health problems (Table 1) also suggests a population of average eye health.

Data collection Data were transmitted wirelessly to a remote, secure database for analysis (Starfield Technologies, Scottsdale, AZ). Item-level responses in the survey were occasionally lost due to user phone error, or loss of connection to the remote database, resulting in missing data points in some of the surveys. This resulted in the total responses of the individual items in Table 1 not adding to total number of respondents (603 individuals).

Statistical Analysis Prevalence of vitreous floaters was calculated by dividing the number of respondents reporting them by the total number of valid responses to that question. We used two outcome measures: whether someone saw vitreous floaters and whether their floaters were "moderate or severe" (3 out of 5 or higher on the severity question). The reference group for both is those who reported not seeing floaters. In unadjusted analyses, differences in the distribution of baseline characteristics between patients who reported seeing floaters and those who did not see them were evaluated using a χ^2 test. We assessed potential risk factors for floaters in a logistic regression model adjusting for vision status (nearsighted, farsighted, other vision problem), age group (24-34, 35+), gender, race (black, Hispanic, Asian), and eye color (blue, green, hazel, brown), reference categories being white, females ages 18-24, emmetropes, and brown eyes respectively. We further stratified our sample into myopes and hyperopes and compared them to those with emmetropes. Two-tailed statistical significance was defined as $P \leqslant 0.05$. All statistical analyses were performed using STATA MP version 12.0 (STATA Corp, College Station, Texas, USA).

RESULTS

Android Smartphone Application and Respondent Characteristics Our smartphone application was downloaded and used by individuals worldwide. The majority of respondents were from the United States (64%), followed by Australia, Israel, and United Kingdom, which together comprised 10%, with the remainder from a variety of nationalities. Floater prevalence did not vary by country of origin (data not shown). The final respondent sample was predominantly male, white, and relatively young (Table 1).

Prevalence of Floaters Overall, 76% of respondents reported seeing floaters and 33% of those who responded 'yes' to seeing floaters reported that the floaters were moderate to severe, defined as answering at least at 3 out of 5

Table 1 Characteristics of respondents

Parameters	
Age (a)	[1]29.5±10.7
Gender [% total, (*n*)]	
Male	65.2 (389)
Female	34.8 (208)
Race	
White	57.6 (322)
Hispanic	19.0 (106)
Asian	13.8 (77)
Black	9.7 (54)
Vision	
Normal	45.3 (271)
Myopia	29.3 (175)
Hyperopia	9.9 (59)
Other	15.6 (93)
Medical history	
Diabetes	5.6 (17)
Glaucoma	2.0 (6)
Eye trauma	8.2 (25)
LASIK	4.0 (12)
Iris color	
Brown	51.6 (308)
Blue	22.4 (134)
Hazel	16.1 (96)
Green	9.9 (59)

[1]Reported as mean±SD. *n*=603.

or above on the question of how bothersome floaters are. As shown in Table 2, patients who reported seeing floaters did not vary by any of our baseline characteristics, although those who reported moderate to severe floaters were more likely to have vision problems (P<0.001). Adjusting for covariates revealed no differences either. In one specification, we included controls for comorbid conditions.

Although myopes and hyperopes reported a similar prevalence of floaters, they were several times more likely to report moderate to severe floaters (Table 3). Of note, when the threshold for moderate to severe floaters was set to a score of 4/5 or higher, myopes were 20 times more likely, and hyperopes 11 times more likely(P<0.01) to report severe floaters in the regression model, compared to emmetropes.

Because age is thought to positively associate with floaters, we performed additional logistic regression models as robustness checks (not shown) to examine whether floater prevalence showed associations with different age cutoffs, but none were observed. It is possible that age effects on floaters might be more prominent in myopes or hyperopes, because posterior vitreous detachment (PVD) may occur earlier in these groups. However, stratifying our sample to these groups did not reveal any significant age effect not found in our logistic regression model.

As seen in Table 1, a minority of survey participants reported having diabetes, glaucoma, prior eye injury that required care, and LASIK surgery. Because these are rarer events, we did not include them in the final multivariate analysis used in Table 3. Although our analyses showed trends of greater moderate to severe floater prevalence in those with these conditions, controlling for them in the analysis did not change results (not shown).

Table 2 Prevalence of floaters by respondent characteristics

Parameters	Any floaters	[1]*P* (χ^2 test)	Moderate to severe floaters	[1]*P* (χ^2 test)
Age (a)				
<23	76.3 (%)	0.52	30.2 (%)	0.36
24-34	77.6		35.1	
>34	72.7		32.6	
Gender				
Male	77.2	0.22	30.0	0.51
Female	72.6		36.9	
Race				
White	75.3	0.67	32.2	0.68
Hispanic	74.5		37.3	
Asian	79.2		32.6	
Black	81.5		29.4	
Vision				
Normal	72.3	0.27	25.2	0.001
Myopia	76.6		36.7	
Hyperopia	83.1		38.1	
Iris color				
Brown	78.8	0.20	34.6	0.251
Blue	70.9		37.5	
Hazel	70.8		23.6	
Green	77.2		23.1	

All prevalence values expressed as %. [1] Compared to those with no floaters.

Table 3 Adjusted odds ratios of any or moderate to severe floaters by respondent characteristics

Parameters	Any floaters	*P*	Moderate to severe floaters	*P*
Age (a)				
<23	Ref		Ref	
24-34	1.3 (0.7-2.2)	0.397	1.6 (0.8-3.3)	0.194
>34	0.8 (0.4-1.4)	0.366	0.8 (0.4-1.6)	0.489
Gender				
Female	Ref		Ref	
Male	1.1 (0.7-1.8)	0.710	0.8 (0.4-1.6)	0.477
Race				
White	Ref		Ref	
Hispanic	1.2 (0.6-2.3)	0.599	1.3 (0.5-2.9)	0.602
Asian	1.4 (0.6-3.4)	0.399	1.0 (0.3-2.8)	0.956
Black	1.6 (0.6-4.0)	0.352	2.3 (0.3-3.9)	0.817
Iris color				
Brown	Ref		Ref	
Blue	0.6 (0.3-1.1)	0.095	0.6 (0.3-1.4)	0.245
Hazel	0.8 (0.4-1.5)	0.667	0.4 (0.2-1.0)	0.667
Green	1.2 (0.5-2.8)	0.898	0.8 (0.2-2.5)	0.060
Vision				
Normal	Ref		Ref	
Myopia	1.7 (1.0-2.9)	0.054	3.5 (1.7-7.1)	0.0004
Hyperopia	2.3 (0.9-5.8)	0.065	4.4 (1.5-12.6)	0.0069

DISCUSSION

The primary objective of this research was to conduct an initial prevalence estimate of vitreous floaters in a younger community sample. In this sample, floaters are very common, occurring in a majority of the respondents and causing at least some vision impairment in about a third.

Prior reports describing clinical populations that were seeking help for floaters have noted that a high proportion are myopes[4,10]. Our data support this assertion and extend it to a more general, non-clinical population, finding that although floaters are noticed equally by those with normal and impaired vision, myopes and hyperopes are much more likely to report floaters that notably interfere with vision.

The mechanism (s) underlying the greater floater severity in myopes and hyperopes compared to emmetropes is not clear.

PVD is thought to be responsible for at least some cases of floaters, and is noted to occur earlier and possibly be more prevalent in myopes [4, 10, 12]. This has led to speculation that PVD may be a main driving mechanism behind the greater prevalence of floaters in myopes[11].

Our results, however, also suggest a high prevalence of vision-impairing floaters in hyperopes compared to myopes, even though hyperopes have a different lens and overall eye architecture compared with myopes and may not be as likely to develop PVD. There is thus currently no known relationship between hyperopia and mechanisms that might predispose to floaters.

Floaters are also typically thought to increase with age; however, we did not observe an age effect in this survey, although the vast majority of our respondents were younger, with few (<5%) above age 50. It is possible that age effects on floaters are not readily noticeable until age ranges beyond those typical of this survey. Indeed, PVD occurrence does not seem to sharply increase until approximately the fifth decade[13], which is largely beyond the scope of this survey.

Diseases of the eye, such as diabetic retinopathy, are thought to associate with floaters [12]. The clinical consequences of diabetic retinopathy progress with age, and the probability of eye injury and other diseases also increases with age. It is possible that these somewhat common health problems may underlie at least some of the more serious cases of floaters observed in clinics. This correlation may have led to the longstanding clinical observation of more frequent severe floaters in older individuals.

Preliminary results from our data do suggest a higher proportion of floaters in those reporting eye injury or related diseases, but the number of reporting these conditions was too low to draw firm conclusions in this survey. It would be of interest in the future to focus on floaters in populations with such eye conditions.

Study Limitations This survey has several limitations, most notably, that most respondents were younger. Because less than 5% of respondents were over age 50, it is not possible to extrapolate floater prevalence or covariation with other eye conditions to the geriatric population such as PVD, which tends to occur in older individuals. Thus, this survey cannot comment on physiological changes in the vitreous that might occur in these older populations. Although we designed this survey to minimize recruitment bias towards those with floaters, it is still likely that other biases exist. For example, those with fewer floaters may be more likely to read and take internet surveys in general. Also, those most likely to complete the survey might have been more interested in their own eye health, and possibly more likely to suffer from floaters. This survey was also limited to the Android market, although we do not have reason to believe that prevalence would vary according to smartphone app services. Overall, this survey provides important data on floater prevalence among young smartphone users, but additional studies in other populations, especially older ones, are needed.

In conclusion, the majority of respondents to this survey reported seeing floaters, and approximately one-third reported that floaters interfere with vision. In line with this, floaters are a common complaint of patients seeking help at eye clinics. Generally speaking, the medical community has responded to floater complaints by giving reassurance without offering any medical intervention or more substantive evaluation. It is perhaps not surprising that patients have expressed frustration at this, and have created a number of advocacy websites to offer support and discuss alternative treatment options, including laser vitreolysis, which has little data to support efficacy, as well as other untested homeopathic treatments[14].

Substantial proportions of patients have reported in surveys that they would be willing to tolerate considerable theoretical risks associated with a potential treatment for floaters, even including a small risk of blindness [2]. This suggests that vitreous floaters should be viewed not just as a physiologic curiosity, but rather as a real health concern deserving more intensive study into its causes and potential treatment.

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