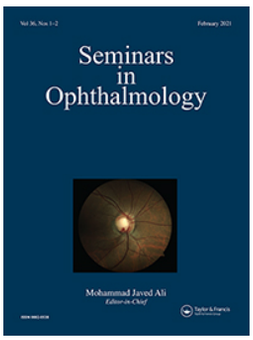

Taylor & Francis
Taylor & Francis Group

Seminars in Ophthalmology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/isio20

How Do Patients Feel About Visual Field Testing? Analysis of Subjective Perception of Standard Automated Perimetry

Núria Mendieta, Joel Suárez, Noelia Barriga, Roger Herrero, Begoña Barrios & Mercè Guarro

To cite this article: Núria Mendieta, Joel Suárez, Noelia Barriga, Roger Herrero, Begoña Barrios & Mercè Guarro (2021) How Do Patients Feel About Visual Field Testing? Analysis of Subjective Perception of Standard Automated Perimetry, Seminars in Ophthalmology, 36:1-2, 35-40, DOI: 10.1080/08820538.2021.1884270

To link to this article: https://doi.org/10.1080/08820538.2021.1884270

Published online: 15 Feb 2021.

SEMINARS IN OPHTHALMOLOGY
2021, VOL. 36, NOS. 1–2, 35–40
https://doi.org/10.1080/08820538.2021.1884270

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

How Do Patients Feel About Visual Field Testing? Analysis of Subjective Perception of Standard Automated Perimetry

Núria Mendieta[a,b,c], Joel Suárez[b,d], Noelia Barriga[b,d], Roger Herrero[e], Begoña Barrios[e], and Mercè Guarro[c,d]

[a]Glaucoma Department, Hospital De l'Esperança, Barcelona, Spain; [b]Glaucoma Department, Institut Oftalmològic Creu Groga, Calella, Barcelona, Spain; [c]Glaucoma Department, Oftalmologia Mèdica I Quirúrgica, Barcelona, Spain; [d]Glaucoma Department, Hospital General De Granollers, Barcelona, Spain; [e]Glaucoma Department, Hospital De Mollet, Barcelona, Spain

ABSTRACT

Purpose: A high rate of unreliability is an issue in visual field (VF) testing, especially in elderly patients, and warrants patient education. We assessed whether subjective perception of the visual field test (VFT) is a good predictor of its reliability in different age groups and examined age differences in patients' awareness of VF damage.

Methods: This cross-sectional study investigated 107 VFT results of 54 patients with glaucoma or ocular hypertension. Subjective perceptions were compared to reliability indices for cooperation analysis and to mean deviation results for VF damage analysis, and an age-segregated sub-analysis was performed.

Results: Kappa coefficients showed poor agreement between subjective and objective parameters. Nevertheless, there were age differences. Younger patients had a higher positive predictive value and sensitivity in cooperation analysis and a higher negative predictive value in VF damage analysis.

Conclusions: Patients' perception of cooperation in VFT is a poor predictor of its reliability. Although young cooperative patients may be aware of their good cooperation, even the youngest are unaware of their poor performance. This emphasizes the importance of giving proper directions to all patients during VFT to obtain better reliability indices. Younger, healthy patients are more aware of their health status, than those with a damaged VF, regardless of age. Therefore, illness education is crucial in all glaucoma patients.

ARTICLE HISTORY
Received 7 August 2020
Revised 5 January 2021
Accepted 18 January 2021

KEYWORDS
Glaucoma; visual field test; perimetry; subjective perception; reliability

INTRODUCTION

Glaucoma is the leading cause of irreversible blindness worldwide. In 2002, the World Health Organization estimated that there were 4.5 million blind people as a result of this disease,[1] and it is expected to have increased to 11 million by the current year due to population aging.[2] Glaucoma treatment is focused on slowing disease progression by reducing intraocular pressure (IOP).[3] Hence, an early diagnosis is fundamental to minimize glaucoma disability. Diagnosing glaucoma is challenging due to the asymptomatic nature of the disease, until it reaches an advanced stage.[4] Even in developed countries, 50% of patients are undiagnosed.[5] For these reasons, it is vital to increase glaucoma screening and improve monitoring of disease progression.

Standard automated perimetry is the preferred method for diagnosis and follow-up of functional loss due to glaucoma.[6] This may be significantly relevant in some patients with suspected glaucoma, such as those who have had refractive surgery, due to the imprecision of IOP measurements.[7] The subjective nature of this test is the most limiting factor. Therefore, obtaining reliable tests is imperative; studies show that 30% of tests are unreliable.[8] Many publications have focused on finding solutions to address this problem. The importance of perimetrist training has been shown, as an inexperienced technician could negatively influence the test result. Furthermore, there are tools available for visual field (VF) assessment in uncooperative patients: faster strategies during VF tests (VFTs), selective perimetry that stimulates responses from specific subsets of ganglion cells,[9] fundus perimetry that is useful in patients with unstable fixation because it includes an eye tracker to compensate eye movements during a VFT,[10] or electrophysiological studies that measure retinal ganglion cell function and circumvent the subjectivity of VFTs.[11] These tests may complement traditional VFTs in cases of uncertain field defects. Another promising approach to optimize accuracy is machine learning.[12] Machine learning can learn complex patterns and trends in data. This allows experts to diagnose and evaluate progression[13] earlier than both functional and structural traditional methods.[14]

Moreover, studies have shown that improving patient conditions, such as optimal vision and greater alertness, and providing better directions to perform the test, among other factors, contribute to a reliable VFT.[15] A better understanding of how the patient feels during a VFT could help technicians give more accurate instructions to improve reliability indices.

Only one study has assessed patients' perception of their cooperation during a VFT,[15] which found no difference in reliability rates between subjects who rated their VFT performance well from those who thought their performance was poor. This study included patients from a wide age range, from 40 to 85 years old. It is known from previous studies that VFT

CONTACT Núria Mendieta nuriamendieta@gmail.com Glaucoma DepartmentHospital De l'Esperança, Barcelona, Spain.

reliability is age-dependent[16]; hence, it is reasonable to suspect that there could be age differences in the results of the previous study,[15] but it was not evaluated.

Aside from difficulties in glaucoma monitoring, another significant issue in this disease is poor adherence to therapy, which may lead to visual loss. In a study of glaucoma treatment adherence in the United Kingdom, over half of patients demonstrated poor adherence.[17] This can be due to numerous factors, including a patient's awareness of their own illness. It is widely known from previous studies that most glaucoma patients are unaware of their VF loss.[18,19] This unawareness exposes the need to provide better health education to these patients in order to improve treatment adherence rates. It has been proved that younger patients are less compliant,[17] but it has not been studied whether they are in turn more unaware of their illness than elderly patients.

We aimed to first assess if subjective perception of VFT performance was a good predictor of actual reliability indices in different age groups. Secondly, we aimed to evaluate, within each age group, if there was an association between the patients' awareness of their VF damage while performing the VFT and actual VF damage.

METHODS

This cross-sectional observational study was conducted in the Ophthalmology Department of Hospital de Granollers (Barcelona, Spain) between October 2016 and May 2017. It was approved by the Ethical Committee of our institution and complied with the tenets of the Declaration of Helsinki.

The study included 107 VFTs from 54 patients with glaucoma or ocular hypertension who came to our hospital for a scheduled VFT. Additional inclusion criteria were visual acuity of 20/40 or higher, undergoing static automated SITA Standard perimetry 24–2 (Humphrey Field Analyzer II; Carl Zeiss Meditec, Jena, Germany) and mean defect better than −20 dB. Exclusion criteria were correction over ± 5 D or greater than 2.5 D of astigmatism, pupil diameter less than 2 mm, or the presence of other ocular pathologies that could influence VFT results with the exception of cataract.

All VFTs were performed and explained by the same optometrist (RH). After VFT completion, a questionnaire was given to all patients who consented to participate in the study. The first question asked them to rate their cooperation during the VFT (very good, good, average, poor, or very poor) for each eye. The second question asked if they thought their cooperation was better in one of the two eyes tested, and if so, to specify which eye was better. The last question addressed the patients' perception of their VF damage in each eye (no damage, mild damage, moderate damage, or severe damage). The questionnaire is available as *Supplemental Material*. (http://doi.org/10.6084/m9.figshare.12771119).

For the objective analysis of reliability, three reliability indices were used: fixation loss, false negatives, and false positives (%). If all indices were lower than 15%, the test was considered reliable. If the VFT was reliable and the patient rated their cooperation as very good or good, the subjective and objective parameters were considered to be in agreement. There was also agreement if the VFT was not reliable and the patient rated their cooperation as average, poor, or very poor. The best eye of each patient was the one with the best reliability rating once the percentages of the three categories had been added up.

For the objective evaluation of VF damage, VFs were considered glaucomatous if the Anderson criteria[20] were met. Therefore, two out of the three following events had to take place: Glaucoma Hemifield Test results outside normal limits, pattern standard deviation $p < 5\%$, and a minimum of three clustered points with significantly depressed sensitivity, one of them with a significance of $p < 1\%$. Mean deviation (MD) scores were used to categorize VFs according to the Hodapp classification of glaucoma severity[21]: early glaucoma if MD was better than −6 dB, moderate glaucoma if MD was between −6 and −12 dB, and advanced glaucoma if MD was worse than −12 dB. First, an analysis was conducted considering all glaucoma categories; a simplified one was then performed considering the VF as normal or glaucomatous.

Data were analyzed all together, and afterwards, they were segregated in two groups depending on the patient's age. Patients under 65 years old were clustered in the younger group and those aged 65 and over in the older group.

STATISTICAL ANALYSIS

The chi-squared test was used to evaluate the association between the patients' perception and actual VFT results. The strength of agreement between the two categorical variables was measured by Cohen's kappa coefficient. Patients' perception was also treated as if it were a diagnostic test, which could predict actual test results. Predictive values (positive predictive value [PPV] and negative predictive value [NPV]) and validity indices (sensitivity [S] and specificity [SP]) were calculated. In the cooperation analysis, the PPV was defined as the proportion of patients who rated their cooperation as good and performed a reliable test (true positives) out of all patients who rated their performance as good. Conversely, the NPV represented the proportion of patients who rated their cooperation as bad and performed an unreliable test (true negatives) out of all patients who rated their performance as bad. Sensitivity was calculated by dividing the true positives by the sum of all patients who performed a reliable test; for specificity, true negatives were divided by the sum of unreliable tests. In damage analysis, the PPV was defined as the proportion of patients who thought that their VF was damaged and had a damaged test (true positives) out of all patients who said that they had a damaged test. The NPV represented the proportion of patients who thought that their VF was normal and had a normal test (true negatives) out of all patients who thought that they had a normal test. Sensitivity was calculated by dividing the true positives by the sum of all patients who had a damaged VF; for specificity, true negatives were divided by the sum of normal tests. Differences between the two age groups were checked through a Z-test. *P* values lower than 0.05 were considered statistically significant.

SPSS (IBM, Armonk, NY) and the online calculator Epitools (*https://epitools.ausvet.com/au/ztesttwo*) were used for all analyses.

RESULTS

A total of 107 VFTs from 54 patients were included in our study (33 women, 21 men, average age 63.5 years). All results were presented for all patients together and then divided by age

into two groups. There were 54 patients in the younger group (<65 years) and 53 patients in the older group (≥65 years).

Out of all 107 VFTs, 67 were reliable. The younger group had 40 reliable tests and 14 unreliable tests, and the older group had 27 reliable and 26 unreliable tests. The difference in the proportion of reliable tests in the two age groups was significant (p = .014). The cooperation analysis results are displayed in *Figure 1* and *Table 1*. There were no significant associations found in either group, and kappa coefficients showed poor agreement between subjective and objective cooperation parameters. Diagnostic test values are also shown in *Table 1*. There were significant differences between the two groups in sensitivity (younger, 87.5%; older, 59.3%; p = .0079) and in PPV (younger, 77.8%; older, 53.3%; p = .0259). There were no significant differences in specificity or NPV.

Twenty patients believed that they had better cooperation in the right eye, fifteen thought that they performed better in the left eye, and seventeen replied that they performed equally. Only 19 patients guessed their best eye correctly. The correlation between the patients' perception of their best eye in terms of collaboration and actual reliability indices was not significant (p = .165) and showed poor agreement (κ = 0.182).

For the second part of the data analysis related to VF damage, only the 67 reliable VFTs were used. One VFT had to be discarded from the analysis because the patient did not

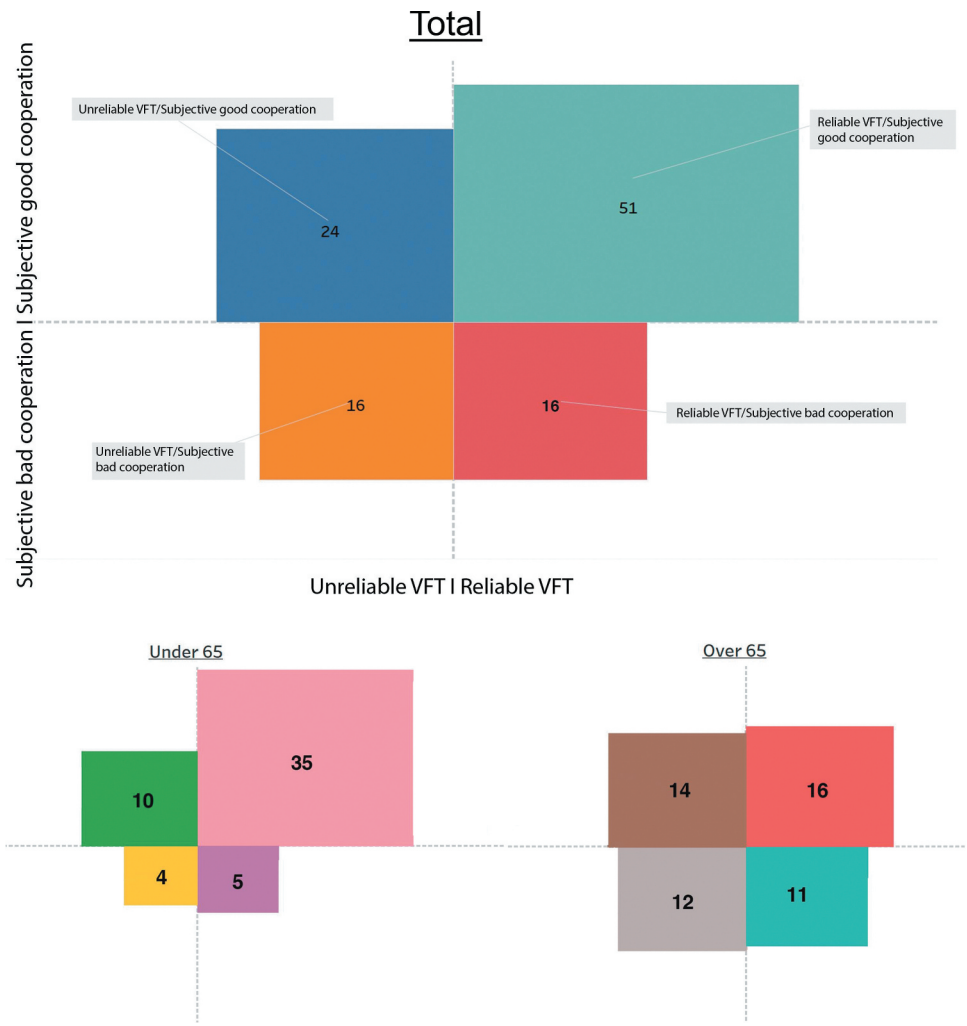

Figure 1. These charts show a 2 × 2 matrix of the cooperation results. They provide a good visualization of the correlation between subjective answers and objective reliability measurements. The upper box displays the global data, and the lower boxes display the data segregated by age. VFT = visual field test.

Table 1. Results from the cooperation analysis.

	Chi square test	Cohen's Kappa coefficient	Positive predictive value	Negative predictive value	Sensitivity	Specificity
Total	p = 0.078	κ = 0.168	68%	50%	76.1%	40%
Under 65 y	p = 0.165	κ = 0.182	77.8%	44.4%	87.5%	28.6%
Over 65 y	p = 0.691	κ = 0.054	53.3%	52.2%	59.3%	46.2%
Z-test	-	-	p = .0259*	p = .9662	p = .0079*	p = .2886

Y = years old.
* p < 0.05, significant values.

answer the second part of the questionnaire. Of these 66 VFTs, 39 were from the younger group and 27 from the older group.

A first analysis was conducted considering the different levels of damage, which was not significant ($p = .550$) and showed poor agreement ($\kappa = 0.036$). Thereafter, a more simplified analysis was performed by clustering all levels of damage to divide the results into two categories: normal VF and damaged VF. An age-segregated sub-analysis was also performed (*Figure 2* and *Table 2*). There were no significant associations found in either group, and kappa coefficients showed poor agreement between subjective and objective VF damage. The kappa coefficient was negative in the older group ($\kappa = -0.161$). The NPV was 85.7% in the younger group, compared with 45.5% in the older one, which was significantly different ($p = .0163$). Differences in PPV, sensitivity, and specificity were not significant.

DISCUSSION

Patient perception during VFT performance has been poorly studied. Only one study has assessed patients' perceptions of their cooperation during a VFT.[15] That study included 140 patients ranging from 40 to 85 years old, and it showed no significant differences in reliability indices between patients who claimed to have performed well and those who thought their cooperation was poor.

The results of our study, which show no significant correlation between patients' perception of cooperation and the reliability indices of the test, are consistent with those of Dersu et al.[15] As a matter of fact, the patients in our study could not identify the eye they performed better with. Moreover, our study segregated patients according to age. To our knowledge, this is the first work to study VFT cooperation perception and its

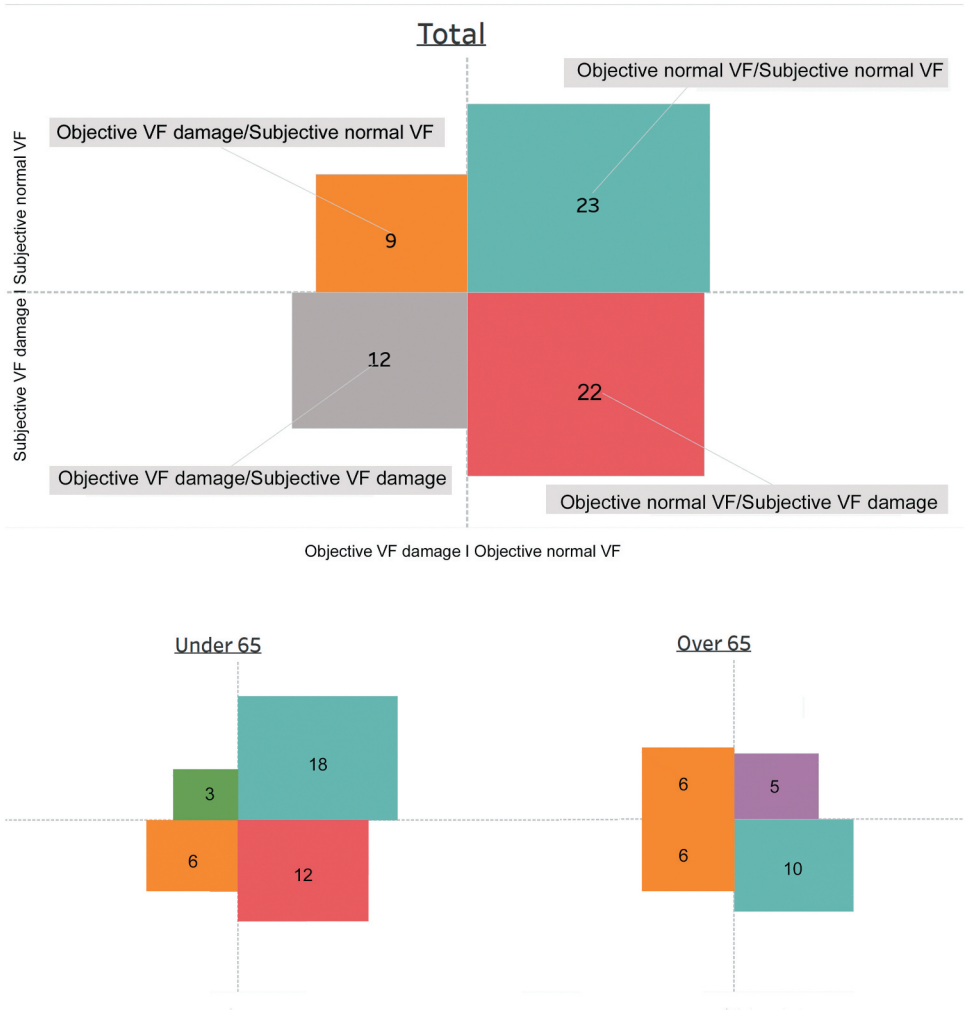

Figure 2. These charts show a 2 × 2 matrix with the visual field damage results. They provide a good visualization of the correlation between the subjective perception of damage and objective damage measurements. The upper box displays the global data, and the lower boxes display the data segregated by age.

Table 2. Results from the damage analysis.

	Chi square test	Cohen's Kappa coefficient	Positive predictive value	Negative predictive value	Sensitivity	Specificity
Total	P = 0.532	K = 0.071	35.3%	71.9%	57.1%	51.1%
Under 65 y	P = 0.159	K = 0.071	33.3%	85.7%	66.7%	60%
Over 65 y	P = 0.380	K = −0.161	37.5%	45.5%	50%	33.3%
Z-test	-	-	$p = .7981$	$p = .0163$*	$p = .4638$	$p = .0912$

Y = years old.
* $p < 0.05$, significant values.

association with age. This sub-analysis was performed based on the evidence that VFT reliability is age-dependent. In agreement with the study by Swaminathan et al.,[16] which showed poorer cooperation in VFTs as age increased, we obtained a significantly higher number of unreliable tests in the older group.

The younger group (<65 years) was significantly different from the older group in the cooperation analysis. The younger group had higher sensitivity and a higher PPV than the older group, which could be interpreted as younger patients being more aware of their good performance during the test. On the other hand, patients that performed poorly were not aware of their poor cooperation in any subgroup, even in the younger group.

Obtaining unreliable VFTs hinders patient evaluation. This study emphasizes the importance of giving the patient a full explanation before performing the test. Furthermore, as patients with low reliability indices are unaware of their poor performance, they should receive clarifications after the test on why they have not performed well. Based on which reliability index is high, the ophthalmologist can explain what has gone wrong, like whether they have not maintained eye fixation, if they pressed the button too many times, or if they missed stimuli. Having a greater understanding of their performance may help the patient to improve it for the next VFT.[22,23]

Glen et al.,[24] in an investigation using groups of open discussion with glaucoma patients, confirmed how important it is for patients to receive clear instructions before the VFT. Furthermore, they concluded that, once the test is finished, patients prefer to be informed about their condition by the ophthalmologist without having to request it, as some find asking for feedback intimidating.

Moreover, special attention must be paid with elderly patients. They may have more difficulties understanding a VFT, get tired easily, and may struggle to maintain their head in position due to neck or back issues. In addition, as glaucoma is a chronic disease, they usually have greater VF damage than younger patients. These factors can make them feel unmotivated and can adversely affect the quality of results. As a matter of fact, the VFT is considered the most unpleasant test of all those performed during glaucoma follow-up visits.[25] Although elderly patients may require more help by the technician, patient education must be performed in all patients regardless of age. As our study demonstrated, being young does not imply a better awareness of poor cooperation.

In the second part of our study, patients' perceptions of VF damage were analyzed. The younger group had an NPV of 87.5%. This indicates that young patients with no perception of damage in their VF probably had no damage in their VF. However, this could be affected by prior knowledge of their eye health. On the other hand, the NPV in the older group was 45.5%, which was significantly different. However, there was no significant difference in PPV between groups and the percentages were low, suggesting that in patients with damaged VF there was no connection between their subjective perception and the VFT result. In fact, there was a strong difference between subjective and objective parameters in the older group, with a negative kappa coefficient. A negative kappa coefficient here means that the probability of a patient identifying their own VF status is lower than if they guessed it randomly. This supports the idea that these patients are completely lost in how to answer this question.

These results demonstrate that patients' perception is a poor predictor of VFT results. It seems unlikely that their subjective perception could be an indicator of the severity of their visual disability. Hoste[18] suggests that VF defects are probably filled in by the brain using information received from the surrounding retina, making the patient unable to notice their visual problem until a late disease stage. This unawareness explains the proportion of patients in our study with objective damage who did not self-report damage. In a 50-patient study, Crabb et al. showed that 26% of patients with VF damage were unaware of their vision loss. Blurred or missing patches were reported by 70% of patients, while tunnel vision was only described by 4% of patients.[19] These results suggest that glaucoma patients do not perceive vision loss according to their VF scotomas.

However, our study had a higher proportion of patients with a normal VF who self-reported damage. This may indicate how difficult it is for patients to understand the test and the anxiety that it causes them, which leads them to think that they have a damaged VF.[26]

Younger patients have proved to be less compliant, but our study indicates that they are as unaware of VF damage as elderly patients. Therefore, their higher rate of non-compliance cannot be justified by an unawareness of their illness. It may be due to a more active lifestyle or long working periods, which can lead to forgetfulness.[17]

As highlighted previously, patients' unawareness of their cooperation and their VF status has been proved in other studies. Hence, the contribution of this study is the age segregation, which confirmed that only young patients with good cooperation may be aware of their performance. Moreover, young patients with healthy VFs may be aware of their VF status. However, young and old patients with poor cooperation and/or a damaged VF, which are the patients of interest in glaucoma healthcare, are unaware of both points. These novel findings may guide ophthalmologists to patients that may need more assistance.

Despite being one of the few studies to analyze patients' perceptions towards VFTs and to empower patients' perspectives, the present study has some limitations. It included a small number of patients; therefore, studies with larger sample sizes are required to confirm our results. The sample size was particularly small in the second part of the study, where awareness of illness was assessed, as only reliable tests could be used. In addition, patients may have answered the questionnaire based on previous information explained in prior visits. Patients may have known their VF condition or may have been informed about their reliability while undergoing previous VFTs. Future studies could be performed with exclusively newly diagnosed patients who could answer the questionnaire without previous information. Moreover, given that binocular VFTs are more useful to reflect patients' difficulties in their daily activities,[27,28] this technique could correlate better with patients' subjective perception.[29] This point was already mentioned by Asaoka et al.,[30] where they concluded that binocular measures can more precisely determine the Visual Field Index than monocular ones and are more aligned with the patients' visual function.

In summary, this study demonstrates that patients, regardless of age, are unaware of their poor cooperation when undergoing a VFT. In addition, patients with glaucoma are unaware of their VF damage. These results indicate the necessity of giving patients clear instructions to obtain a reliable VFT and how important it is

to make them aware of their own illness to ensure treatment adherence.

Abbreviation

VF = visual field

Acknowledgments

The authors would like to thank Gemma Molist, PhD, biostatistician from Hospital de Granollers, Barcelona, Spain, for performing all statistical analyses, Lluís Abio, Degree in Mathematics, MSc in Quantitative Finance and CFO of Global Vision Care SCP, Barcelona, Spain, and Mireia Ibarzo, VFX Compositor, for designing all the graphic material for the study.

Data availability statement

The data that support the findings of the study are openly available in Figshare at http://doi.org/10.6084/m9.figshare.12443594.v1

Disclosure of interest

The authors report no conflict of interest.

Funding

No funding has been received to support this work.

ORCID

Núria Mendieta http://orcid.org/0000-0001-6291-1326

References

1. Resnikoff S, Pascolini D, Etya'ale D, et al. Global data on visual impairment in the year 2002. *Bull World Health Organ*. 2004 Nov;82(11):844–851. /S0042-96862004001100009.
2. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol*. 2006 Mar;90 (3):262–267. doi:10.1136/bjo.2005.081224.
3. Heijl A, Leske MC, Bengtsson B, Hyman L, Bengtsson B, Hussein M. Reduction of intraocular pressure and glaucoma progression: results from the early manifest glaucoma trial. *Arch Ophthalmol*. 2002 Oct;120(10):1268–1279. doi:10.1001/archopht.120.10.1268.
4. Leite MT, Sakata LM, Medeiros FA. Managing glaucoma in developing countries. *Arq Bras Oftalmol*. 2011 Mar-Apr;74(2):83–84. doi:10.1590/S0004-27492011000200001.
5. Medical Advisory Secretariat. Routine eye examinations for persons 20-64 years of age: an evidence-based analysis. *Ont Health Technol Assess Ser*. 2006;6(15): 1–81.
6. Alencar LM, Medeiros FA. The role of standard automated perimetry and newer functional methods for glaucoma diagnosis and follow-up. *Indian J Ophthalmol*. 2011 Jan;59(Suppl1):S53–8. doi:10.4103/0301-4738.73694.
7. Samuelson TW. Refractive surgery in glaucoma. *Curr Opin Ophthalmol*. 2004 Apr;15(2):112–118. doi:10.1097/00055735-200404000-00010.
8. Katz J, Sommer A, Witt K. Reliability of visual field results over repeated testing. *Ophthalmology*. 1991 Jan;98(1):70–75. doi:10.1016/S0161-6420(91)32339-X.
9. Sethi S, Fay C, Bollinger KE. Functional testing in glaucoma diagnosis. *Curr Ophthalmol Rep*. 2013 Apr;13(1):89–97. doi:10.1007/s40135-013-0010-8.
10. Conigliaro P, Triggianese P, Draghessi G, et al. Evidence for the detection of subclinical retinal involvement in systemic lupus erythematosus and Sjögren syndrome: a potential association with therapies. *Int Arch Allergy Immunol*. Jun 2018;177(1):45–56. doi:10.1159/000488950.
11. Maleki A, Lamba N, Ma L, Lee S, Schmidt A, Foster CS. Rituximab as a monotherapy or in combination therapy for the treatment of non-paraneoplastic autoimmune retinopathy. *Clin Ophthalmol*. 2017 Feb;17(11):377–385. doi:10.2147/OPTH.S120162.
12. Yousefi S, Goldbaum MH, Zangwill LM, Medeiros FA, Bowd C. Recognizing patterns of visual field loss using unsupervised machine learning. *Proc SPIE Int Soc Opt Eng*. 2014 Mar 21;2014:90342M. doi:10.1117/12.2043145.
13. Yousefi S, Goldbaum MH, Balasubramanian M, et al. Learning from data: recognizing glaucomatous defect patterns and detecting progression from visual field measurements. *IEE Trans Biomed Eng*. 2014 Jul;61(7):2112–2124. doi:10.1109/TBME.2014.2314714.
14. Yousefi S, Goldbaum MH, Balasubramanian M, et al. Glaucoma progression detection using structural retinal nerve fiber layer measurements and functional visual field points. *IEEE Trans Biomed Eng*. Apr 2014;61(4):1143–1154. doi:10.1109/TBME.2013.2295605.
15. Dersu II, Ali TK, Spencer HJ, Covey SM, Evans MS, Harper RA. Psychomotor vigilance and visual field test performance. *Semin Ophthalmol*. 2015 Jul;30(4):289–296. doi:10.3109/08820538.2013.859279.
16. Swaminathan SS, Greenberg MB, Vanner EA, Cavuoto KM, Wellik SR, Chang TC. The effect of patient characteristics and sleep quality on visual field performance reliability. *J Ophthalmol*. 2018 Feb 12;2018:2731260. doi:10.1155/2018/2731260.
17. Tse AP, Shah M, Jamal N, Shaikh A. Glaucoma treatment adherence at a United Kingdom general practice. *Eye (Lond)*. 2016 Aug;30(8):1118–1122. doi:10.1038/eye.2016.103.
18. Hoste AM. New insights into the subjective perception of visual field defects. *Bull Soc Belge Ophthalmol*. 2003;287:65–71.
19. Crabb DP, Smith ND, Glen FC, Burton R, Garway-Heath DF. How does glaucoma look?: patient perception of visual field loss. *Ophthalmology*. 2013 Jun;120(6):1120–1126. doi:10.1016/j.ophtha.2012.11.043.
20. Anderson DR, Patella VM. *Automated Static Perimetry*. 2nd. St. Louis: Mosby; 1999.
21. Hodapp E, Parrish Rk IIP, Anderson DR. Clinical decisions in glaucoma. St Louis: The CV Mosby Co; 1993. 52–61.
22. Heijl A, Bengtsson B. The effect of perimetric experience in patients with glaucoma. *Arch Ophthalmol*. 1996 Jan;114(1):19–22. doi:10.1001/archopht.1996.01100130017003.
23. Werner EB, Krupin T, Adelson A, Feitl ME. Effect of patient experience on the results of automated perimetry in glaucoma suspect patients. *Ophthalmology*. 1990 Jan;97(1):44–48. doi:10.1016/S0161-6420(90)32628-3.
24. Glen FC, Baker H, Crabb DP. A qualitative investigation into patients' views on visual field testing for glaucoma monitoring. *BMJ Open*. 2014 Jan 10;4(1):e003996. doi:10.1136/bmjopen-2013-003996.
25. Gardiner SK, Demirel S. Assessment of patient opinions of different clinical tests used in the management of glaucoma. *Ophthalmology*. 2008 Dec;115(12):2127–2131. doi:10.1016/j.ophtha.2008.08.013.
26. Chew SS, Kerr NM, Wong AB, Craig JP, Chou CY, Danesh-Meyer HV. Anxiety in visual field testing. *Br J Ophthalmol*. 2016 Aug;100 (8):1128–1133. doi:10.1136/bjophthalmol-2015-307110.
27. Parrish RK, SJ G, IU S, et al. Visual function and quality of life among patients with glaucoma. *Arch Ophthalmol*. Nov 1997;115 (11):1447–1455.
28. Musch DC, Niziol LM, Gillespie BW, Lichter PR, Janz NK. Binocular measures of visual acuity and visual field versus binocular approximations. *Ophthalmology*. 2017 Jul;124(7):1031–1038. doi:10.1016/j.ophtha.2017.02.013.
29. Viswanathan AC, McNaught AI, Poinoosawmy D, et al. Severity and stability of glaucoma: patient perception compared with objective measurement. *Arch Ophthalmol*. Apr 1999;117(4):450–454. doi:10.1001/archopht.117.4.450.
30. Asaoka R, Russell RA, Malik R, Garway-Heath DF, Crabb DP. Five-year forecasts of the Visual Field Index (VFI) with binocular and monocular visual fields. *Graefes Arch Clin Exp Ophthalmol*. 2013 May;251(5):1335–1341. doi:10.1007/s00417-012-2214-2.