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CORRELATION OF VISUAL FIELD LOSS TO ACTIVITIES OF DAILY LIVING DISTURBANCE ON GLAUCOMA OUTPATIENTS IN SURABAYA

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ABSTRACT
Introduction: Glaucoma is known as a thief of sight due to its progressive visual field loss with symptoms typically manifesting only at advanced stages. Visual field loss, particularly peripheral vision, can affect patients' quality of life (QoL) in performing activities of daily living. Glaucoma cases are predicted to rise by 74% worldwide between 2013 and 2040. **Aims:** Assess the correlation between the degree of visual field loss and disturbance in activities of daily living in glaucoma outpatients. **Methods:** A total of 60 patients from Dr. Soetomo General Academic Hospital were interviewed using the NEI VFQ-25 on near vision, distance vision, peripheral vision, social function, driving, and dependency subscales. Visual field loss was assessed using the Humphrey Visual Field Analyzer (HFA) and categorized based on the Hodapp, Parish, and Anderson (HPA) classification using the better-eye mean deviation value. Meanwhile, Spearman's rank correlation was used to determine the correlation between the patients' visual field loss and NEI VFQ-25 interview results. **Results:** Significant moderate correlations were observed between visual field loss and the social function (r = 0.545) and dependency (r = 0.483) subscales. Significant weak correlations were observed in the near vision (r = 0.351), distance vision (r = 0.383), and peripheral vision (r = 0.398) subscales. An insignificant weak correlation was observed in the driving subscale (r = 0.262). **Conclusion:** Visual field loss in glaucoma patients is associated with activities of daily living disturbance, with the severity of limitation increasing in line with the progression of visual field loss.

Keywords: glaucoma, visual field loss, activities of daily living

INTRODUCTION

Glaucoma is one of the public health issues that requires considerable attention. It is well known as the thief of sight due to its progressive visual field loss (VFL) with symptoms typically manifesting only at advanced stages. Many patients, including those with bilateral visual field loss, do not view their impaired vision as a problem. However, the asymptomatic nature of vision loss makes this disease particularly dangerous (Crabb, 2016). Once visual field loss occurs, vision cannot be restored to normal. Therefore, treatment is primarily aimed at preventing further loss (Kaur & Kochar, 2016). Approximately 76 million people globally were affected by glaucoma in 2020, with the number projected to reach 111.8 million by 2040 and Asia contributing the highest number of cases. This also represents a 74% from 2013 to 2040, primarily due to an anticipated increase in the aging population (Tham et al., 2014). Data from the Indonesian Basic Health Research (*Riset Kesehatan Dasar*/Riskesdas) in 2007 reported a glaucoma prevalence of approximately 0.46%, indicating that 4 to 5 out of every 1,000 Indonesian citizens are affected.

Intraocular pressure (IOP) has been identified as a key risk factor for the advancement of visual field loss (Musch et al., 2011). Visual impairment significantly impacts well-being and is a major contributor to disability, such as reduced social participation. Additionally, a diagnosis of progressive visual loss can affect a patient's quality of life (QoL), highlighting the psychological burden of the disease (Shah, Frank, & Ehrlich, 2020; Klauke, Sondocie & Fine, 2023). Visual

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field loss, particularly peripheral vision, in glaucoma patients can affect their vision-related quality of life (VR-QoL), influencing daily tasks such as social functioning, dependency, mobility, reading, emotional well-being, and driving (Lange et al., 2021).

Patients with advanced glaucoma face significant challenges in performing daily activities and often have a negative perspective of their limitations. Furthermore, individuals with bilateral visual field loss due to glaucoma experience reduced visual capabilities and impaired task performance, especially in areas such as driving and mobility (Ramulu, 2009). The aging population is at a higher risk of driving cessation and limitations due to glaucomatous visual field loss (Van Landingham et al., 2013). A prior study discovered a correlation between visual field loss severity and increased activity limitations (Miguel et al., 2015).

However, few studies have focused on the impact of visual field loss severity in glaucoma patients on their ability to perform activities of daily living, particularly in Indonesia. Therefore, this study aims to evaluate the correlation between visual field loss severity and activities of daily living disturbance in glaucoma outpatients at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

METHODS

This study used an explanatory cross-sectional approach conducted on glaucoma outpatients at Dr. Soetomo General Academic Hospital in Surabaya, East Java, Indonesia. Data collection was carried out from July 24 to August 22, 2023. Disturbance in patients' activities of daily living were assessed using the National Eye Institute Visual Functioning Questionnaire (NEI VFQ-25) version 2000 on six subscales: near vision, distance vision, peripheral vision, social function, driving, and dependency. Patient medical records were used to obtain demographic data such as gender and age, as well as clinical characteristics such as best corrected visual acuity (BCVA), intraocular pressure (IOP), history of ocular surgery, and mean deviation (MD) values from the results of Humphrey Field Analyzer 3 (HVF) by ZEISS. Participants were selected using a consecutive sampling technique. Only patients who met the inclusion criteria were included, namely glaucoma patients with a minimum age of 18 years who was willing to be interviewed and had a HVF examination result. Patients with a negative visual acuity or blindness in both eyes were excluded from this study. Ethical clearance was granted by the Ethical Committee of Dr. Soetomo General Academic Hospital through a Letter of Exemption (No. 1376/LOE/301.4.2/VII/2023) on July, 2023. Prior to participation, patients provided written informed consent after receiving an explanation of the study.

The severity of visual field loss (VFL) was classified according to the Hodapp, Parish, and Anderson (HPA) classification, namely mild, moderate, and severe visual field loss. The classification includes several indicators from the HVF results, such as mean deviation (MD), the number of points depressed below the 1% and/or 5% levels on the pattern deviation plot, and sensitivity values within the central 5°. However, for the purpose of this study, the classification was based solely on the MD value. Patients with an MD value less than -6 dB were categorized as having mild visual field loss, those with MD values between -6 dB to -12 dB as having moderate visual field loss, and those with MD values greater than -12 dB as having severe visual field loss.

Patients were interviewed using the NEI VFQ-25 as previously described. In the subscales of near vision, distance vision, peripheral vision, and social function, the patients responded to questions regarding the level of difficulty when performing specific activities. Six response options were provided: no difficulty at all (1), a little difficulty (2), moderate difficulty (3), extreme difficulty (4), stopped doing the activity due to eyesight problems (5), and stopped doing the activity due to other reasons or due to lack of interest (6). Responses were then converted to a 0 to 100 scale, with higher scores indicating better functioning: response (1) to 100, (2) to 75, (3) to 50, (4) to 25, and (5) to 0. Response (6) was treated as missing data as it did not reflect vision-related limitations and was excluded from the scoring. For the dependency subscale, five response options were available: definitely true (1), mostly true (2), not sure (3), mostly false (4), and definitely false (5). These responses were also converted to a 0 to 100 scale: response (1) to 100, (2) to 75, (3) to 50, (4) to 25, and (5) to 0. All scoring procedures followed the guidelines provided in the NEI VFQ-25 manual.

All data, including patient demographics, clinical characteristics, MD values, and interview scores were compiled using Google Sheets. These data, including the subscale scores and the MD values, were then imported into IBM SPSS Statistics for Macintosh version 26.0 for statistical analysis. Spearman's rank correlation was used to evaluate the correlation between variables, specifically the MD values and functional scores across six subscales of activities of daily living, for a total of 60 patients.

RESULTS

Demographic Characteristics

From July 24 to August 22, 2023, a total of 63 patients were initially interviewed. However, only 60 patients were included in the final analysis, as three were excluded due to not meeting the inclusion criterion of being at least 18 years old. The participants ranged in age from 18 to 80 years, with a mean age of 43,43 years. Table 1 shows that there were a total of 22 male patients (36.7%) and 38 female patients (63.3%). BCVA was categorized as no visual impairment, mild visual impairment, moderate visual impairment, severe visual impairment, and blindness. Of the total, 24 patients (40%) were categorized as having no visual impairment, 10 patients (16%) as having mild impairment, 13 patients (21.7%) as having moderate impairment, nine patients (15%) as having severe impairment, and four patients (6%) as blind.

Clinical Characteristics

HVF data were used to classify the patients into three categories of visual field loss based on the HPA classification. This classification uses the mean deviation (MD) values as follows: mild visual field loss (MD greater than -6 dB), moderate visual field loss (MD between -6 dB and -12 dB), and severe visual loss (MD less than -12 dB). Based on this classification, 26 patients (43.3%) were categorized as having mild visual field loss, 12 patients (20%) as moderate, and 22 patients (36,7%) as severe. In terms of IOP, the mean IOP in the right eye for 59 patients was 19.37 ± 8.905. One patient's right-eye IOP could not be determined. Meanwhile, the mean IOP in the left eye for 58 patients was 19.12 ± 8.906. Two patients' left-eye IOP could not be determined (see Table 2). Data on patients' ocular disease and surgical history were also collected. A total of 17 patients (28.3%) had undergone cataract surgery, five (10%) had glaucoma surgery, one each undergone the following procedures: amniotic membrane transplant (AMT), vitrectomy, iridectomy, 1 patient had gone trabeculectomy and glaucoma drainage device (GDD), strabismus surgery, and cyclocryotherapy. The remaining 32 patients (53.3%) reported no surgical history.

Correlation Between Visual Field Loss and Activities of Daily Living

The results of the Spearman's rank correlation analysis are presented in Table 3. The analysis examined the correlation between the severity of visual field loss and each subscale of the NEI VFQ-25. The

Spearman's coefficients (r) in this study ranged from 0.351 to 0.545 with a significant result ($p < 0.05$). However, the correlation for the driving subscale was not significant, with a coefficient of 0.262 ($p > 0.05$). Only 22 patients (36.7%) were included in the analysis for the driving subscale, as 19 patients had never driven in their lifetime and the other 19 had stopped driving. The mean values for the near vision, distance vision, peripheral vision, social function, dependency, and driving subscales are illustrated in Figure 1, whereas the mean values for each subscale based on the severity of visual field loss are illustrated in Figure 2.

Table 1. Demographic Characteristics of Patients

Variable	Value
Gender	
Male	22 (36.7%)
Female	38 (63.3%)
Age	
Mean Value	43.43 ± 19.49
Range (min to max)	18.00 – 80.00

Table 2. Clinical Characteristics of Patients

Variable	n = 60 (Percentage)
Best Corrected Visual Acuity (BCVA)	
No visual impairment (≥6/12)	24 (40.0)
Mild (6/18 - <6/12)	10 (16.0)
Moderate (6/60 - <6/18)	13 (21.7)
Severe (3/60 - <6/60)	9 (15.0)
Blindness (NLP - <3/60)	4 (6.0)
Mean Deviation of Better Eye and Visual Field Loss Type	
Mild (>-6 dB)	26 (43.3)
Moderate (-6 to -12 dB)	12 (20.0)
Severe (<-12 dB)	22 (36.7)
Intraocular Pressure (IOP)	
Right Eye	
Mean value ± SD	19.37 ± 8.905 (59 patients)
Left Eye	
Mean value ± SD	19.12 ± 8.906 (58 patients)
Patient History of Ocular Surgery	
Cataract surgery	17 (28.3)
Glaucoma surgery	5 (10)
Amniotic membrane transplant (AMT)	1 (1.70)
Vitrectomy	1 (1.70)
Iridectomy	1 (1.70)
Trabeculectomy and glaucoma grainage gevice (GDD) Surgery	1 (1.70)
Strabismus surgery	1 (1.70)
Cyclocryotherapy	1 (1.70)
No surgery	32 (53.3)

Table 3. Correlation Between Visual Field Loss and Six Subscales of NEI VFQ-25

Variable	r	*p*-value
Visual field loss with near vision	0.351	0.006*
Visual field loss with distance vision	0.383	0.003*
Visual field loss with peripheral vision	0.398	0.002*
Visual field loss with social function	0.545	0.000*
Visual field loss with driving (n = 22)	0.262	0.239
Visual field loss with dependency	0.483	0.000*

Notes: *Correlation was considered significant at the 0.01 level (2-tailed), r: Spearman's correlation coefficient.

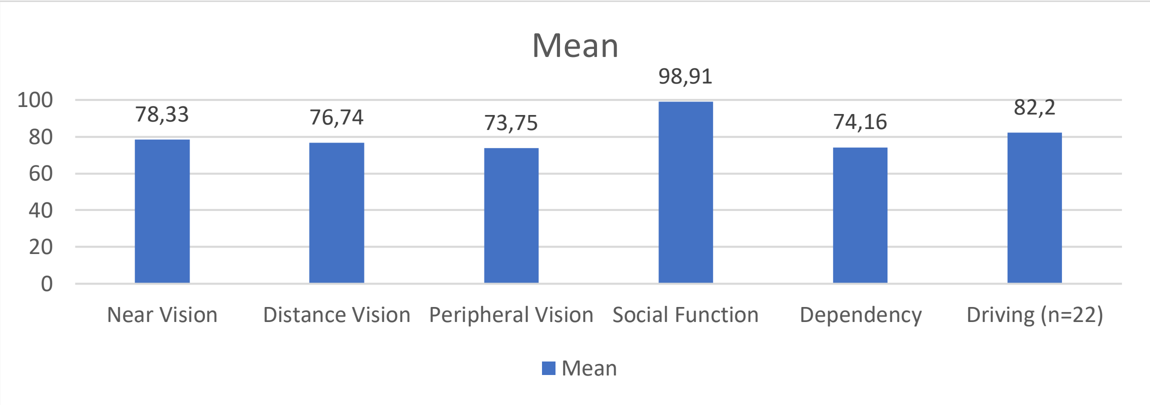

Figure 1. Mean values of 60 subjects across subscales of the NEI-VFQ 25. Each subscale represents a group of questions focusing on a specific aspect of visual function to assess difficulties or limitations in a specific area.

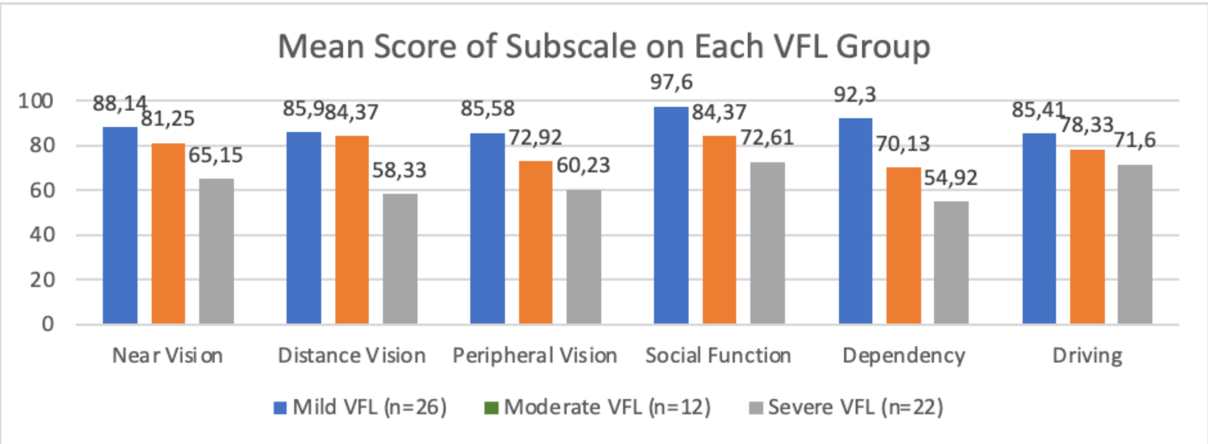

Figure 2. Mean values of subjects categorized by severity of visual field loss

DISCUSSION

Demographic and Clinical Characteristics of Glaucoma Patients

With a total of 60 glaucoma outpatients, this study found that women had a higher disease prevalence than men. As the global population ages and glaucoma cases rise, older women in particular are at risk for glaucoma and glaucoma-related blindness. This is attributed not only to their longer life expectancy, but also socioeconomic challenges and health beliefs (Vajaranant et al., 2010). This finding is consistent with a prior study by Machado et al. (2019) who also used the NEI VFQ-25 as an assessment tool and reported a higher prevalence of glaucoma in women than in men.

According to a review, risk factors for glaucoma progression include a history of elevated IOP, age, non-Caucasian ethnicity, and a family history of glaucoma (Worley & Grimmer-Somers, 2011). Sharma and Singh (2016) similarly identified these demographic risk factors. In this study, the mean age of the participants was 43.43 ± 19.49 years, with ages ranging from 18 to 80 years. Another study found that secondary glaucoma mostly affected individuals aged between 21 and 50 years (Komaratih, Rindiastuti, & Primitasari, 2020). However, glaucoma can occur at any age of life. The mean IOP in this study was 19.37 ± 8.905 for the right eye (n = 59) and 19.12 ± 8.906 for the left eye (n = 58). IOP data were unavailable for one patient's right eye and two patients' left eyes due to negative palpation results during examination. IOP elevation and fluctuation are strong indicators of progressive visual field loss (Musch et al., 2011). IOP is regulated by the balance between aqueous humor secretion and drainage and is associated with retinal ganglion cell death. Elevated IOP leads to remodeling of the optic disc tissues and lamina cribrosa, which becomes thinned and displaced posteriorly and eventually results in vision loss. These changes deepen the optic disc cup and narrow the rim. Structural changes in the lamina cribrosa may obstruct axonal transport within the retinal ganglion cells, leading to apoptosis. The death of ganglion cells and loss of optic nerve fibers cause alterations in the retinal nerve fiber layer and optic nerve head appearance. Eventually, this loss culminates in gradual visual field loss (Weinreb, Aung, & Medeiros, 2014).

The classification of visual impairment based on BCVA in this study showed varying results from no visual to blindness. Specifically, 24 patients had no visual impairment, 10 had mild impairment, 13 had moderate impairment, nine had severe impairment, four were classified as blind. Although glaucoma does not lead to a decline in visual acuity until its advanced stages, assessing BCVA remains important as it provides insights into patients' functional vision and ability to perform daily tasks (Richman et al., 2010). Patients with older age, greater baseline damage, higher peak IOP, pseudoexfoliative glaucoma, and a history of glaucoma-related surgical interventions are associated with faster progression of glaucomatous visual field loss (Kim et al., 2019).

Correlation Between Visual Field Loss and Disturbance in Activities of Daily Living

This study supports previous findings suggesting that greater visual field loss is associated with increased limitations in daily activities. Miguel et al. (2015) discovered an association between the severity of visual field loss and increased activity limitations, with patients in advanced stages of glaucoma experiencing significant challenges in performing daily activities. As illustrated in Figure 2, the mean scores for daily task performance in this study decreased across all subscales as the severity of visual field loss increased. A previous hospital-based study showed significantly lower QoL among glaucoma patients compared to individuals without glaucoma, particularly among those with severe VFL (Dhawan et al., 2019). Interestingly, individuals with unilateral visual impairment or visual field loss may not experience difficulties in carrying out activities of daily living because the better eye compensates for the worse one (Azoulay-Sebban et al., 2020). A literature review indicated that VFL in the better eye has a more substantial impact on QoL than in the worse eye, and that QoL further declines as the visual field in the worse eye becomes more severe. (Quaranta et al., 2016). In contrast, Machado et al. (2019) identified the MD value of the worse eye as a strong factor associated with QoL.

A study by Huang et al. (2020) found that social function in glaucoma patients is lower than in individuals without visual impairment. In this study, the social function subscale showed the strongest correlation with VFL among all subscales, indicating that as visual field loss increases, social functioning tends to decline (see Figure 2). Patients in the severe VFL group frequently reported difficulties in recognizing other people's reactions than in visiting others. Shah, Frank, and Ehrlich (2020) emphasized a strong consensus that visual impairment is associated with reduced social participation. As glaucoma progresses, particularly to the point where facial recognition becomes impaired, quality of life declines and the risk of depression increases (Klauke, Sondocie and Fine, 2023). Another study found that glaucoma patients with severe visual field loss face challenges in socializing, such as attending communal, religious, and cultural events, traveling, and maintaining relationships, even with a normal central vision. These patients reported lower satisfaction with their ability to go out and engage in social activities than individuals in earlier stages of the disease (Yang et al., 2016). Therefore, visual impairment, whether affecting peripheral or central visual field, can reduce patients' social functioning, including limitations in recognizing people's reactions, responding to social cues, and visiting places.

Visual impairment caused by ocular diseases such as glaucoma can negatively impact an individual's driving ability and safety. Older drivers, in particular, should be aware of the potential impact of their eye condition on their driving performance (Wood & Black, 2016). In this study, patients reported several driving limitations, including challenges with nighttime driving, navigating in rainy conditions, traveling in unfamiliar places, driving less than one hour from home, and restricting driving to their neighborhood. These findings are consistent with previous research that glaucoma patients tend to avoid challenging driving conditions such as nighttime, highways, heavy traffic, rush hour, fog, and rain more frequently than individuals without glaucoma (Schacknow & Samples, 2010). According to Wood et al. (2016), impaired driving performance is commonly observed in older glaucoma patients with mild to moderate visual field loss, particularly in complex driving situations requiring accurate lane positioning, planning, and observation. It was also observed that they predominantly confine their driving to standard road systems.

The correlation between the driving subscale and visual field loss was weak and insignificant (r = 0.130). This may be attributed to the fact that most elderly people in Indonesia do not drive themselves, and a significant proportion of the participants were non-drivers. As previously stated, only 22 patients were interviewed because the others had either stopped driving or had never driven in their lifetime. In this study, 19 patients (31.67%) reported that they had stopped driving: 10 due to visual reasons, seven due to other reasons, and two due to a combination of both reasons. A clinic-base study showed that patients diagnosed with glaucoma were substantially more likely to reduce or cease driving compared to glaucoma suspects. Driving limitations and cessation were more prevalent in the severe visual field loss group. An effective strategy to reduce the risks of visual field loss is to stop driving (Van Landingham et al., 2013). A study by Ramulu et al. (2009) showed that patients with bilateral visual field loss are more inclined to stop driving compared to those with unilateral visual field loss, as bilateral impairment more significantly affect driving safety and independence. Interestingly, this study identified eight patients who continued to drive despite having vision in only one functional eye, while the other eye showed no light perception or was completely blind. This finding suggested that driving limitations beyond the extent of visual field loss. A systematic review indicated that both binocular and monocular visual field loss negatively affect driving performance, with binocular visual field loss causing more challenges than monocular visual field loss. The review also emphasized that central defects tend to cause more problems than peripheral defects (Patterson et al., 2019).

Kwon et al. (2017) found that a reduction in functional visual field is associated with limitations in reading speed among glaucoma patients. Various types of reading are affected by advanced visual field loss, which contributes to the self-limiting reading behavior. This finding is consistent with the findings of this study, where the patients' average performance on near-vision activities decreased significantly as visual field loss increased (see Figure 2). In addition to reading, this study also evaluated the patients' ability to locate objects on a crowded shelf and to perform activities that require close-range vision. Mild to moderate glaucomatous visual impairment has been shown to reduce visual search ability (Lee, Wood and Black, 2020). In this study, the correlation between visual field loss and the peripheral vision subscale was moderate and significant (r = 0.398). This suggested that greater visual field loss is associated with increased difficulty in detecting objects from the side (see Figure 2). A previous cross-sectional study on glaucoma outpatients by Nayyar et al. (2022) reported that limitations in activities requiring peripheral vision and dark adaptation or glare have the highest influence on QoL in patients with moderate glaucoma. As glaucoma advances to its severe stage, a significant decline in QoL is primarily attributed to restrictions in activities involving central and near vision.

A weak but significant correlation (r = 0.383) was found in this study between visual field loss and the distance vision subscale. Distance vision-related activities assessed included going out to watch movies, plays, or sports events, descending steps, stairs, or curbs in dim lighting or at night, and reading street signs or store names. A previous population study reported that patients with peripheral visual field loss were likely to stay away from large crowds or unfamiliar settings such as airports, concert venues, or shopping centers. A number of patients also reported difficulties in watching movies as theaters felt too dark, with screens that were too large for their limited peripheral vision (Lange et al., 2021).

The largest difference in values between mild and severe visual field loss groups was observed in the dependency subscale (difference = 37.38). A moderate and significant correlation was also found for this subscale (r = 0.483), indicating that patients' dependency decreased as visual field loss increased. This subscale included questions about whether patients stayed at home most of the time, often relied on what others say, or required a lot of help from others due to their vision. This study found that patients with severe VFL tended to stay at home due to their condition compared to those with mild and moderate VFL. As the severity increased, a greater number of patients required assistance from others and became more reliant on others' words. A study on the British population found that visually impaired participants often reported feeling safer at home as it was a familiar and comfortable environment. In addition to loss of independence, visually impaired individuals also experienced limitations in participating in hobbies or social events (Jones, Bartlett, & Cooke, 2019).

McKean-Cowdin et al. (2007) stated that patients with VFL had the greatest difficulties in mental health, dependency, distance vision, peripheral vision, and driving-related tasks. Health-related quality of life (HRQoL) was affected even those with mild VFL, as indicated by their MD scores. As far as the authors are concerned, there are not many earlier studies that have specifically assessed how visual field loss diminishes distance vision-related activities nor dependency. However, a study on a Chinese population concluded that severe visual impairment correlates with marked declines in independence and mobility, with glaucoma and cataracts separately contributing to poorer outcomes. Mobility limitations caused by visual impairment can lead to a loss of independence and reduced QoL (Fenwick et al., 2016).

This study is the first to assess the correlation between visual field loss to disturbance in activities of daily living (ADL) in glaucoma outpatients, primarily within the authors' institution. A notable finding in this study is that most patients did not experience difficulties in driving, which is due to driving cessation among the majority of the study population. Glaucoma patients in Indonesia tend to stop driving or not drive at all with the disease. Driving cessation due to visual impairment was more prevalent in the group with severe visual loss. On the other hand, some patients were still able to engage in driving activities even with a monocular vision.

This study has several limitations, including the use of a cross-sectional approach to assess the correlation between the two variables, which only captures disturbance in ADL during a certain period. Additionally, not all patients had the most recent HVF data, as some had not yet reached the time of their scheduled six-month follow-up.

There is a potential bias and subjectivity in patients' responses to the NEI VFQ-25 questions despite the efforts to clearly explain the intent of each question. Participants were selected using consecutive sampling. Consequently, not all glaucoma patients who regularly attend outpatient check-ups at Dr. Soetomo General Academic Hospital had an equal opportunity to be interviewed. Moreover, the HPA classification in this study was only based on the MD value, although other criteria such as points depressed below the 1% and/or 5% on the pattern deviation plot and sensitivity value within the central 5° could be considered. The classification of glaucoma patient into mild, moderate, and severe did not differentiate between central or peripheral visual field loss. This study also did not specify the type of visual field test, whether the 10-2, 24-2, or 30-2 HVF, as it relied on the available records from patients' examinations.

CONCLUSIONS

In conclusion, there is a significant correlation between visual field loss and disturbance in activities of daily living in the subscales of near vision, distance vision, peripheral vision, social function, and dependency. However, there is no significant correlation in the driving subscale. The average values of each activity of daily living subscale decrease as the severity of visual field loss increases.

Further studies are required to assess glaucoma patients' activity of daily living using more specific assessments tools and the most recent MD values. This will ensure that the disturbance in activities of daily living that the patient is experiencing accurately reflects the current severity of visual field loss.

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