Prevalence and Consequences of Perceived Vision Difficulty in Aging Adults with HIV Infection

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• PURPOSE: **Despite well-known ocular complications of HIV-related immune suppression, few studies have examined the prevalence and consequences of visual impairment among aging long-term survivors of HIV.**

• DESIGN: **Retrospective cohort study.**

• METHODS: **Aging HIV-infected (HIV+) men who have sex with men (MSM) and HIV-uninfected (HIV−) MSM controls reported their difficulty performing 6 vision-dependent tasks (difficulty defined as: no, a little, moderate, and extreme difficulty). Relationships were examined using logistic regression, regressing each outcome separately on categorical visual function responses, with missing data multiply imputed.**

• RESULTS: **There were 634 age-matched pairs for a total sample of 1,268 MSM of 1,700 MSM with available data. The median age was 60 years old (interquartile range [IQR], 54, 66), and 23% were African American. Among HIV+ men, 95% were virally suppressed (viral load <400 copies/mL). HIV+ men were more likely to report moderate or extreme difficulty performing at least 1 task (21% for HIV+ compared to 13% for HIV−; $P < .01$). Participants reporting extreme vision-related difficulty performing at least 1 task had 11.2 times the odds of frailty (95% confidence interval [CI], 5.2-23.9), 2.6 times the odds of a slow gait speed (95% CI, 1.4-4.8), and 3.2 times the odds of impaired instrumental activities of daily living (95% CI: 1.6-6.3) compared to those reporting no vision-related difficulty on any task.**

• CONCLUSIONS: **Perceived vision difficulty was more common among older HIV+ MSM than age-matched HIV− MSM controls and was associated with higher risk of depression and physical function loss among MSM. (Am J Ophthalmol 2020;218:268–278. © 2020 Published by Elsevier Inc.)**

VISION IMPAIRMENT IS HIGHLY PREVALENT IN OLDER adults[1–3] and affects many functional domains. HIV-infected (HIV+) adults in the United States represent a vulnerable aging population potentially at higher risk of vision impairment than the general population due to long-term exposure to HIV viremia, and they likely face additional barriers to vision care. The prevalence of vision impairment and ocular disease in the aging US HIV+ population is not currently known. However, older HIV+ adults are at high risk for many chronic age-related comorbidities and exhibit accelerated functional decline.[4,5]

Older studies from the pre- and early- highly active antiretroviral treatment (HAART) era examining the impact of acquired immunodeficiency syndrome (AIDS) on vision and eye disease outcomes found impaired contrast sensitivity and color vision were more common among HIV+ persons,[6–13] and cataract was twice as prevalent in AIDS patients compared to an HIV-uninfected (HIV−) population sample.[14] However, relationships among those who are long-term survivors of HIV infection have been poorly studied and are less clear. Inflammation, which persists even after viral suppression, has been implicated in the higher risk of many age-related comorbidities noted among HIV+ persons in the modern therapy era,[15,16] and could play a role in increasing the risk of vision impairment and ocular disease.

In this study, we used data from the Multicenter AIDS Cohort Study (MACS), an ongoing prospective observational cohort of successfully treated, aging HIV+ men who have sex with men (MSM) and comparable HIV− MSM. We examined the prevalence of perceived vision difficulty and self-reported ocular disease and associations with aging outcomes, including physical, social and emotional function and comorbidity. It was hypothesized that HIV+ MSM would have a higher burden of perceived vision difficulty compared to HIV- MSM and that vision difficulty would be associated with higher functional loss among this vulnerable group.

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MATERIALS AND METHODS

• **MULTICENTER AIDS COHORT STUDY:** Established in 1984, the MACS is an ongoing observational study of HIV+ and HIV−MSM from four clinical sites: Baltimore, MD/Washington, DC; Chicago, IL; Los Angeles, CA; and Pittsburgh, PA/Columbus, Ohio.[17] At semi-annual visits participants undergo physical examinations and give blood and urine samples for laboratory analyses and storage. Standardized questionnaires are used to collect health, behavior and HIV treatment history. The study adhered to the guidelines of the Declaration of Helsinki. Each participant gave informed consent and each local institutional review board approved the study.

For the present cross-sectional study, we included all men who responded to at least 1 vision-related question during the period from September 2017 to March 2018.

• **EYE CARE AND EYE DISEASE:** Participants self-reported medical diagnoses related to the eye since the last visit, and these diagnoses were coded using International Classification of Diseases, ninth revision by trained study interviewers. Participants were also asked when the last visit to a doctor, ophthalmologist, or eye specialist concerning their vision occurred. No objective measurements of vision function have ever been captured in the MACS.

• **MEASUREMENT OF VISION-RELATED DIFFICULTY:** To assess the occurrence of perceived complications and limitations resulting from vision problems, a modified version of the National Eye Institute (NEI) Visual Function Questionnaire (VFQ) was included in the MACS interview battery.[18,19] Six questions were used to assess the difficulty experienced by respondents with tasks that required aspects of vision. Participants were instructed to assess any difficulties due to their vision and to rate their ability to perform the tasks while wearing glasses or contacts (if worn). Tasks included reading fine print, doing hand work or hobbies, going upstairs in dim light, noticing objects while walking, locating objects on a shelf, and driving during the day (Supplemental Appendix material is available at www.ajo.com). The 5 response options were: no difficulty, a little difficulty, moderate difficulty, extreme difficulty, unable to do this task because of eyesight. Participants were also asked for an assessment of their overall vision function (with corrective lenses, if worn) with possible answers: excellent, good, fair, poor, or very poor.

• **ASSESSMENT OF AGING OUTCOMES:** Poor vision function may impact a number of aging domains including physical functional, social engagement, and mental health. Outcomes were defined in each domain.

Physical function was assessed using the frailty phenotype adapted for use in the MACS, which required a report of at least 3 of the 5 indicators[20,21]: a) weakness, present if grip strength measured using a dynamometer was less than the 20th percentile of HIV− men; b) slowness, present if the time to walk 4 m was more than 80th percentile of HIV− men; c) unintentional weight loss, present if participant answered "yes" to the question "Since your last visit, have you had unintentional weight loss of at least 10 pounds?"; d) exhaustion, present if the participant answered "yes" to the question "During the past 4 weeks, as a result of your physical health, have you had difficulty performing your work or other activities (e.g., it took extra effort)?"; and e) low physical activity, present if a participant answered "yes, limited a lot" to the question "Does your health now limit you in vigorous activities, such as running, lifting heavy objects, participating in strenuous sports?" Disability was assessed every 12 months using the Lawton-Brody Instrumental Activities of Daily Living (IADL) Questionnaire, with self-reported limitations in performing 8 tasks: housekeeping, money management, cooking, transportation, telephone use, shopping, laundry, and medication management.[22,23] Impaired IADL was defined as a change from best ability toward impairment in one or more areas on the IADL questionnaire.

Social and emotional function was assessed using the 36-item Short Form (SF) instrument, a general measurement of self-reported health-related quality of life using 36 items that addressed 8 domains including social and emotional function.[24–26] Scores are scaled T scores with a mean of 50 and a standard deviation of 10, with higher scores reflecting higher functioning within the domain.[22] The reliability and validity of the SF-36 has been evaluated in HIV+ populations including the MACS.[27,28]

Comorbidities included depressive symptoms, defined as a Center for Epidemiologic Studies Depression Scale score >16 or reported treatment for depression; hypertension, defined as a systolic blood pressure greater than 140 mm Hg or diastolic blood pressure greater than 90 mm Hg or a reported diagnosis of hypertension and current use of blood pressure medication; diabetes, defined as fasting glucose >126 mg/dL, hemoglobin A1c ≥6.5% or a diagnosis of diabetes with use of medication; kidney disease, defined by a confirmed diagnosis from a medical record abstraction; and a risk category of cardiovascular disease using the American College of Cardiology/American Heart Association (ACC/AHA) scale.[29]

• **OTHER COVARIATES OF INTEREST:** Plasma HIV RNA levels (viral load [VL]) were measured using the Amplicor assay (Hoffman-LaRoche, Nutley, New Jersey), sensitive to 50 copies/mL. Viral suppression was defined as having a VL <400 copies/mL. $CD4^+$ T-lymphocyte count (CD4) was measured using 3-color flow cytometry.[30] Steroid use, which is associated with ocular complications, was captured from self-report.

TABLE 1. Demographic and Clinical Characteristics of the 1268 HIV-Infected and -Uninfected Men at the Time of the Visual Difficulty Survey

		HIV Serostatus		
	Overall (N = 1268)	HIV-Uninfected (N = 634)	HIV-Infected (N = 634)	
Characteristic	% or Median (IQR)	% or Median (IQR)	% or Median (IQR)	*P*
Black race	23.3	**20.5**	**26.2**	**.017**
Body mass isdex	26.7 (23.8, 30.0)	27.0 (24.1, 30.5)	26.2 (23.1, 29.8)	.060
Age (years)	60.4 (54.3, 65.9)	60.4 (54.3, 66.0)	60.4 (54.2, 65.9)	.996
Some college	82.6	**85.6**	**79.5**	**.004**
Income				**<.001**
<30,000	37.6	**30.3**	**44.9**	
30,000-60,000	26.9	**27.0**	**26.9**	
≥60,000	35.5	**42.7**	**28.3**	
Moderate to binge drinking	21.2	21.7	20.7	.088
Current smoker	17.9	17.1	18.6	.892
Injection drug use history	1.3	0.9	1.6	.293
Steroid use	22.1	**18.9**	**25.2**	**.011**
Depression	33.8	**30.6**	**37.1**	**.015**
Hypertensive	58.7	55.9	61.4	.059
Diabetes	18.3	**14.6**	**22.0**	**.002**
ACC/AHA risk score ≥0.075	57.8	57.2	58.3	.787
Confirmed chronic kidney disease (CKD)	4.8	**1.7**	**7.9**	**<.001**
Frailty phenotype	11.0	**7.7**	**14.4**	**<.001**
Longer walk time than 80th percentile HIV-	35.6	35.8	35.5	.912
Activities of daily living				**.032**
No impairment	70.4	**73.4**	**67.3**	
Minor impairment	19.2	**18.1**	**20.3**	
Major impairment	10.5	**8.5**	**12.4**	
Health limitation score	95 (80, 100)	95 (85, 100)	95 (70, 100)	1.000
Emotional well-being score	84 (68, 923)	84 (68, 92)	80 (64, 92)	.292
Social functioning score	100 (75, 100)	100 (75, 100)	100 (63, 100)	1.000
HIV-specific variables				
Adherence to HAART (?) <100% of the time			10.8	
CD4 T-cell count			670 (501, 872)	
Virally suppressed (VL<400 cps/mL)			94.6	
Cumulative HAART years		.	14.7 (8.4, 18.8)	

P-values for statistical differences across HIV serostatus groups obtained using χ^2 or Wilcoxon rank sum test at a significance level $P < .05$ after accounting for imputation variability.

Bolded values reach statistical significance.

• STATISTICAL ANALYSIS: As vision and eye disease are highly correlated with age, the HIV+ and HIV− samples were matched on exact year of age. Among the matched sample, multivariate normal imputation[31] was used within each serostatus group to impute missing values across a host of characteristics of interest, creating 20 imputed datasets; vision data were not imputed. The prevalence of self-reported ocular disease and vision-related difficulty were estimated by HIV serological status, and associations with a range of covariates were examined using logistic (for categorical characteristics) and quantile (for continuous characteristics) regression, adjusting variances to account for variability across imputation datasets by using standard multiple imputation methods.[32] Diagnostics for the imputed data were implemented following guidance by Stuart et al.[33] Vision-related difficulty was examined by individual task and also summarized as a categorical variable expressing the highest degree of difficulty reported across tasks with levels: no difficulty on any task, some difficulty on at least 1 task, moderate difficulty on at least 1 task, and extreme difficulty on at least 1 task. Answers to the vision-related questions of "does not do this for other reasons," "refused," "don't know," were treated as missing. A composite score was also created using the NEI VFQ scoring methods.[34] Trends in the prevalence of aging outcomes were described across categories of overall vision-

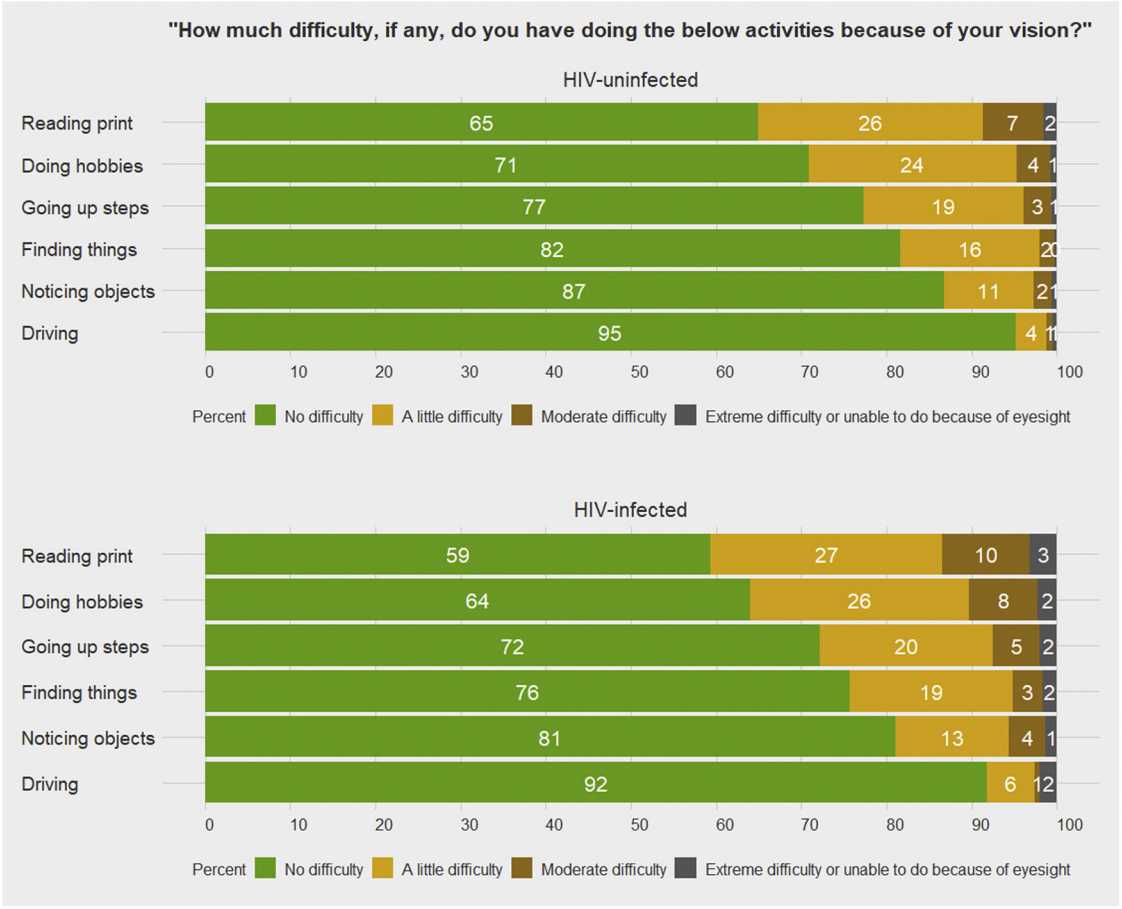

FIGURE 1. Proportion of participants reporting difficulty, due to vision, when performing common daily tasks and activities. The graph shows the percentage of HIV-infected and -uninfected men reporting no difficulty, a little difficulty, moderate difficulty, and extreme difficulty on 6 vision-related tasks.

related difficulty and tested using ordinal logistic regression, adjusting variances to account for variability across imputation datasets.

To examine relationships of self-reported vision-related difficulty with physical and comorbidity outcomes, logistic regression was used to regress each outcome separately on the level of vision-related difficulty using indicator variables with no difficulty as the reference. Models were adjusted for demographics: race, education, and income; and for risk behaviors: injection drug use, drinking and smoking history. Interaction terms between reported vision-related difficulty level and HIV serostatus were used to assess the degree to which associations were differential by HIV serostatus.

RESULTS

• **SAMPLE SELECTION:** There were 1,700 HIV+ and HIV− men who responded to the MACS vision function survey; 82 men (<5%) left the survey blank. Of those who responded, 634 age-matched pairs were found for a total sample size of 1,268. Answers to "does not do this for other reasons," "refused," and "don't know" occurred in <1% of participants for all questions except the question related to driving, in which 5.3% of men reported not performing the activity for reasons other than vision. Percentages of missingness in other covariates prior to imputation ranged from 0% to 47%. Among the matched samples, the median age was 60 years old, and 23% were African American (Table 1). HIV+ men were more likely to be black, and have lower income and educational attainment. They were also at higher risk for most comorbidities, as previously reported.[5,35] Among the HIV+ men, 95% had a VL <400 copies/mL, and the median CD4 count was 670 cells/mL.[3]

• **PREVALENCE OF REPORTED DIFFICULTY ON VISION-RELATED TASKS AMONG HIV+ COMPARED TO HIV−:** Among the 1,268 men, 40% reported some difficulty performing at least 1 task, 12% had moderate difficulty on at least 1 task, and 5% reported extreme difficulty performing at least 1 task, for a cumulative prevalence of

TABLE 2. Self-Reported Ocular Disorders by HIV Serostatus

Eye Diagnosis	HIV Serostatus N (Row %)		
	HIV-Uninfected	HIV-Infected	Total
Cataract	8 (67%)	4 (33%)	12
Chorioretinal inflammations, scars and other disorders of choroid	1 (33%)	2 (67%)	3
Congenital anomalies of eye	0 (0%)	1 (100%)	1
Corneal opacity and other disorders of cornea	1 (50%)	1 (50%)	2
Disorders of conjunctiva	6 (75%)	2 (25%)	7
Disorders of lacrimal system	2 (100%)	0 (0%)	2
Disorders of refraction and accommodation	1 (11%)	8 (89%)	9
Disorders of the globe	0 (0%)	1 (100%)	1
Glaucoma	1 (50%)	1 (50%)	2
Inflammation of eyelids	2 (100%)	0 (0%)	2
Keratitis	1 (50%)	1 (50%)	2
Other	1 (50%)	1 (50%)	3
Other disorders of eye	2 (100%)	0 (0%)	2
Other disorders of eyelids	0 (0%)	1 (100%)	1
Other retinal disorders	1 (100%)	0 (0%)	1
Visual disturbances	0 (0%)	1 (100%)	1
Total	27 (53%)	24 (47%)	51

any perceived vision-related difficulty of 56%. HIV+ men were more likely to report moderate or extreme difficulty (21% for HIV+ compared to 13% for HIV− men; $P < .01$). Looking at individual tasks, HIV+ men reported more difficulty than HIV− men across all vision-related tasks ($P < .01$ for all vision-related tasks) (Figure 1). When items were converted to scores using the NEI VFQ scoring algorithm, mean ± SD composite scores across the 6 items were 93.6 ± 9.5 among HIV− and 90.9 ± 12.7 among HIV+ men, representing a significant difference by HIV serostatus in overall perceived vision-related difficulty ($P < .01$).

• **OCULAR DISORDERS AMONG HIV+ COMPARED TO HIV− MEN:** Overall, there were 51 men (4%) who reported having an ocular disorder (Table 2). The most common condition was cataract (24% of total reported diagnoses) of which 8 of the 12 reported diagnoses (67%) occurred in HIV− men and 4 (33%) in HIV+ men. In contrast, disorders of refraction and accommodation were much more common among HIV+ men, with 89% of the 9 diagnoses reported by HIV+ men. There were no statistically significant differences in the overall frequency of ocular conditions across HIV serostatus groups. Due to the sparsity of other eye diagnoses, comparisons of prevalence between HIV+ and HIV− men were not made.

• **CORRELATES OF PERCEIVED VISION-RELATED DIFFICULTY:** Univariate trends across levels of reported difficulty performing vision-related tasks were assessed for a variety of factors (Table 3). Men reporting more difficulty performing vision-related tasks tended to also report recent visits to a doctor for vision problems and were less likely to report excellent vision (Table 3). A total of 38% of those reporting extreme difficulty with vision-related tasks had not sought medical care for their vision in the previous year. The overall self-assessment of vision function was not strongly correlated with reported difficulty with vision-related tasks ([rho] $\rho = 0.39$). The prevalence of other functional and comorbidity aging outcomes showed significant univariate trends across vision-related difficulty, with generally higher percentages of men experiencing each outcome as vision difficulty increased.

• **ASSOCIATIONS OF VISION-RELATED DIFFICULTY WITH AGING OUTCOMES:** Figure 2 highlights the strong trends noted in the prevalence of most comorbidities and physical function with increasing vision-related difficulty. Table 4 shows the adjusted odds ratios (OR) for these aging outcomes by level of difficulty. Although most comorbidity relationships lost significance after adjustment for demographics and risk behaviors, depressive symptoms remained strongly associated with self-reported vision-related difficulty. Participants reporting moderate or extreme vision-related difficulty had 3- to 4-times the odds of depression compared to those reporting no vision difficulties (OR, 3.3; 95% confidence interval [CI]: 2.1-5.1] and 3.7; 95% CI: 2.1-6.7; respectively). In contrast to comorbidity outcomes, all physical function outcomes remained significantly associated with vision-related difficulty after adjustment. Participants reporting extreme vision-related difficulty performing at least 1 task had 11.2 times the odds of frailty (95% CI:5.2-23.9), 2.6 times the odds of a slow gait speed (95% CI: 1.4-4.8), and 3.2 times the odds of impaired IADL (95% CI: 1.6-6.3)

TABLE 3. Level of Difficulty Performing Vision-Related Tasks Reported as a Function of Various Participant Characteristics

Characteristic	Overall (N = 1268)	Level of Difficulty Performing Vision-Related Tasks: No Difficulty (N = 557)	A Little Difficulty (N = 488)	Moderate Difficulty (N = 153)	Extreme Difficulty (N = 70)	*P*
	Median or %					
HIV-infected (%)	50.0	**46.5**	**48.8**	**59.5**	**65.7**	**.011**
Saw doctor about vision (%)						**<.001**
Less than 1 year	55.3	**55.5**	**53.7**	**56.2**	**62.9**	
At least 1 year but less than 2 years	21.4	**19.7**	**24.2**	**19.6**	**18.6**	
At least 2 years but less than 3 years	9.7	**9.0**	**11.3**	**9.2**	**5.7**	
3-10 years	9.5	**11.1**	**6.8**	**11.8**	**10.0**	
Greater than 10 years	3.7	**3.8**	**3.9**	**3.3**	**2.9**	
Self-reported vision (%)						**<.001**
Excellent	33.8	**46.7**	**27.9**	**17.0**	**8.6**	
Good	49.5	**46.1**	**58.0**	**40.5**	**37.1**	
Fair	14.0	**5.7**	**13.5**	**37.3**	**32.9**	
Poor	1.7	**0.4**	**0.4**	**5.2**	**14.3**	
Very poor	0.5	**0.2**	**0**	**0**	**7.1**	
Depression (%)	34.1	**24.2**	**36.9**	**50.3**	**58.6**	**.013**
Hypertension (%)	58.5	**54.7**	**59.2**	**65.6**	**67.5**	**.006**
Diabetes (%)	19.5	**16.9**	**18.6**	**25.6**	**33.3**	**.001**
ACC/AHA risk categories (%)						**<.001**
<0.05	19.0	25.4	15.2	13.5	6.9	
0.06-<0.075	22.0	**22.8**	**22.3**	**20.5**	**17.1**	
≥0.075	59.0	**51.8**	**62.4**	**66.0**	**76.1**	
Confirmed CKD (%)	4.7	**3.2**	**4.7**	**7.2**	**10.0**	**.006**
Frailty phenotype (%)	11.1	**4.4**	**11.4**	**19.7**	**43.0**	**<.001**
Walk slower than 80th percentile HIV- (%)	36.5	**30.7**	**39.5**	**36.8**	**60.6**	**<.001**
Activities of daily living (%)						**<.001**
No Impairment	69.5	77.0	69.1	57.6	38.4	
Minor Impairment	20.1	**18.4**	**20.4**	**21.4**	**27.9**	
Major Impairment	10.4	**4.6**	**10.4**	**21.0**	**33.8**	
Health limitation score	95	**100**	**91**	**85**	**58**	**<.001**
Emotional well-being score	84	**88**	**80**	**72**	**68**	**<.001**
Social functioning score	100	**100**	**100**	**75**	**63**	**<.001**

Bold indicates a trend across the categories of vision function with significance $P < .05$ after accounting for imputation variability using logistic or quantile regression.

compared to those reporting no vision-related difficulty performing any task.

• **DIFFERENCES AMONG RELATIONSHIPS BY HIV SEROSTATUS:** Interaction terms between HIV infection and level of vision difficulty were not significant, but point estimates were generally higher among HIV+ men for physical function outcomes (Table 5). Among HIV− men reporting extreme vision-related difficulty, the odds of frailty were 5.2 times higher, the odds of slow gait speed were 1.4 times higher, and the odds of impaired IADL were 2.1 times higher. Among HIV+ men, the increased odds were 16.1, 3.8, and 3.9, respectively, representing a 2- to 3-times higher risk among HIV+ men than HIV− men at the same level of reported vision-related difficulty.

DISCUSSION

IN THIS STUDY, HIV+ MSM REPORTED SIGNIFICANTLY MORE difficulty with vision-related tasks than age-matched HIV− MSM. In addition, clear links are shown between self-reported difficulty performing vision-related tasks and higher risk of depression and loss of physical function among MSM. Although interactions between HIV serostatus and vision-related difficulty did not meet a threshold of significance, point estimates hinted at the potential for a higher impact of vision on functional outcomes among HIV+ men. Regardless, reported difficulties with vision-related tasks were more common among HIV+ men, increasing the burden of associated outcomes even in the absence of effect modification by HIV serostatus.

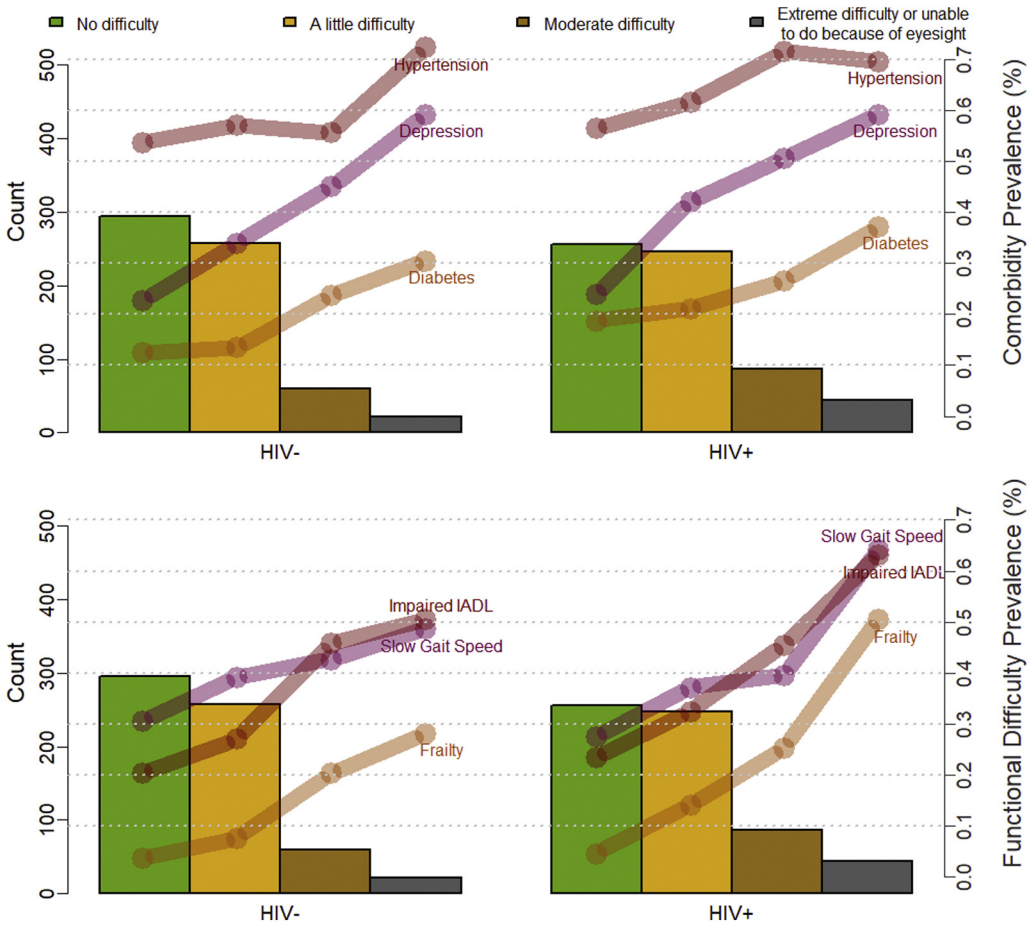

FIGURE 2. Frequency of reported level of difficulty performing vision-related tasks and the associated prevalence of various comorbidities and physical function metrics by HIV serostatus. Bars represent the discrete categories of perceived vision difficulty. Lines show the prevalence of comorbidity or functional outcomes among those reporting each level of perceived vision difficulty, with connecting lines to show the trend. The right-hand y-axis shows the number of HIV-infected and -uninfected men reporting each level of difficulty performing vision-related tasks, and the left-hand y-axis shows the prevalence of various comorbidity and physical function outcomes.

Furthermore, even though self-reported ocular disorders were generally rare in the cohort, disorders of refraction and accommodation were 8-times more common among HIV+ men.

Among the broader aging MSM population, disparities in health and access to care for older MSM adults have been extensively documented.[36] The low numbers of reported ocular disorders could be the result of poor detection and diagnosis if HIV+ and HIV− MSM are not accessing vision care. Inadequate vision care could exacerbate what appears to be a higher burden of vision loss among HIV+ men. Correctable loss of vision that goes uncorrected can contribute to functional loss. For an aging HIV+ population that faces growing health and life complexity,[4] vision loss may represent a tipping point that leads to decline in physical, social, and mental health. In the general population, changes in vision that occur with age such as a loss of contrast sensitivity have been found to affect walking speeds,[37–39] balance,[40–42] and terrain navigation,[43] leading to greater self-reported mobility limitations.[44–46] Work using the National Health and Nutrition Examination Survey demonstrated that vision impairment was associated with 48% less daily moderate-to-vigorous physical activity,[47,48] an important factor in maintaining health and mood. Results from the Salisbury Eye Evaluation Study showed that a decline in vision acuity was associated with a decline in IADLs, which had subsequent implications for mortality.[46,49] It should be noted, however, that vision loss still occurred even in the absence of clinical disease; thus, the noted high burden of difficulties reported with vision-related tasks is not inconsistent with the low prevalence of reported ocular disorders.

Vision impairment has also been linked repeatedly to depression.[50–52] Older adults experiencing vision difficulties may engage less in social and leisure activities,[53,54] contributing to a vicious cycle of decline

TABLE 4. Adjusted Odds Ratios Estimating the Association of Perceived Vision Difficulty with Functional and Comorbidity Outcomes from Logistic Regression

	Level of Perceived Vision Difficulty		
	A Little Difficulty[a,b]	Moderate Difficulty[a,b]	Extreme Difficulty[a,b]
Outcome	OR (95% CI)		
Depression	**2.1 (1.6, 2.8)**	**3.3 (2.1, 5.1)**	**3.7 (2.1, 6.7)**
Hypertension	1.0 (0.7, 1.3)	1.1 (0.7, 1.7)	1.4 (0.7, 2.6)
Diabetes	1.0 (0.7, 1.5)	1.5 (0.9, 2.4)	1.9 (1.0, 3.7)
Kidney disease	1.5 (0.8, 2.7)	2.0 (0.9, 4.5)	1.9 (0.7, 5.3)
Frailty	**2.4 (1.4, 4.3)**	**5.2 (2.7, 10.0)**	**11.2 (5.2, 23.9)**
Slow gait speed	**1.3 (1.0, 1.8)**	1.4 (0.9, 2.1)	**2.6 (1.4, 4.8)**
Impaired IADL	1.4 (1.0, 2.0)	**2.4 (1.5, 3.9)**	**3.2 (1.6, 6.3)**

Bold indicates an odd ratio meeting a statistical significance $P < .05$ after accounting for imputation variability.
[a]Estimates adjusted from logistic regression for age, black race, income, education, injection drug use, drinking behavior, and smoking.
[b]Odds ratios are for the comparison with the reference category of no reported vision difficulty on any task.

TABLE 5. Adjusted Odds Ratios Stratified by HIV Serostatus Estimating the Association of Perceived Vision Difficulty with Functional and Comorbidity Outcomes from Logistic Regression

	Level of Perceived Vision Difficulty					
	A Little Difficulty[a,b]		Moderate Difficulty[a,b]		Extreme Difficulty[a,b]	
	OR (95% CI)					
Outcome	HIV−	HIV+	HIV−	HIV+	HIV−	HIV+
Depression	2.5 (1.7, 3.8)	1.8 (1.2, 2.7)	3.8 (2.1, 6.8)	2.9 (1.6, 5.4)	3.7 (1.8, 7.6)	4.1 (1.6, 10.4)
Hypertension	0.9 (0.6, 1.3)	1.0 (0.7, 1.5)	0.8 (0.4, 1.4)	1.5 (0.8, 2.7)	1.4 (0.5, 4.1)	1.4 (0.5, 3.7)
Diabetes	1.0 (0.5, 1.8)	1.0 (0.5, 2.0)	1.7 (0.8, 3.6)	1.3 (0.6, 2.8)	1.8 (0.6, 5.2)	1.8 (0.7, 4.6)
Kidney disease	3.8 (0.8, 18.6)	1.1 (0.6, 2.3)	4.1 (0.5, 29.9)	1.6 (0.7, 3.8)	NE	NE
Frailty	1.8 (0.8, 4.0)	3.0 (1.4, 6.7)	4.6 (1.7, 12.2)	5.6 (2.1, 14.7)	5.2 (1.5, 18.5)	16.1 (5.4, 48.3)
Slow gait speed	1.3 (0.9, 1.9)	1.4 (0.9, 2.2)	1.3 (0.7, 2.5)	1.5 (0.8, 2.8)	1.4 (0.5, 4.0)	3.8 (1.3, 10.9)
Impaired IADL	1.4 (0.8, 2.3)	1.5 (0.8, 2.7)	2.6 (1.3, 5.1)	2.3 (1.1, 5.0)	2.1 (0.7, 6.5)	3.9 (1.3, 11.9)

NE = not estimable.
No significant interactions at the $P < .05$ level were found in logistic regression interaction models including an interaction between vision-related difficulty and HIV seroststatus.
[a]Estimates adjusted for age, black race, income, education, injection drug use, drinking behavior, and smoking.
[b]Odds ratios are for the comparison with the reference category of no reported vision difficulty on any task.

in physical, mental, and social health that can lead to depression. MSM and HIV+ populations are at higher risk for depression,[55–58] and vision impairment may be adding to that burden. In the present study, depression was consistently associated with self-reported difficulty with vision-related tasks; accordingly, even a little difficulty with performing 1 or more tasks had a 2-fold risk of increased depression compared to those who reported no difficulty with any vision-related tasks.

Perception of vision-related difficulty, although not an objective measurement of peripheral vision function, may be an important indicator of broader limitations, and surveys of vision may help uncover a general profile of physical and health limitations in individuals. In the present age-matched sample, self-reported difficulty performing vision-related tasks was correlated with nearly every aging outcome including comorbidity. There are several potential mechanisms that could link vision loss and aging outcomes among HIV+ men. HIV infection is a context of immune activation and inflammation. Systemic disease and inflammation could contribute to common pathology. Alternatively, behavioral changes due to vision limitations may lead to decline in health. However, the poor correlation between reported overall vision function and reported

difficulty on vision-related tasks may also suggest that the men in the present sample were less able to distinguish between difficulty due to disease-related limitations and difficulty due to vision-related limitations. In the current study, no assessment of peripheral vision function or central visual processing was available, and these data are needed to fully understand mechanisms underlying the high burden of perceived vision difficulty in the cohort.

The present study had several notable limitations. The vision survey was administered at a single study visit, limiting the ability to assess temporality of associations or the reliability of reported limitations. Furthermore, objective vision function measurements and perceived vision-related difficulty are related but not overlapping concepts,[59] and vision impairments may be perceived differently across individuals as a result of various personal and contextual factors. The degree to which individuals with no peripheral vision function loss may still report some level of difficulty is unknown and is likely specific to the population and context. However, prior work has found scores from a similar instrument (the VFQ-25) to be related to HIV-related neuroretinal disorder and loss of contrast sensitivity among a sample of HIV+ men.[60] Missingness was non-negligible in several variables including the IADL survey, which could have limited the ability to accurately impute the information. In addition, self-report of both vision outcomes and functional outcomes could lead to systematic bias (e.g., same source bias) if some participant characteristics tended to skew reporting across all instruments. Finally, HIV+ and HIV− men may differ in a number of unmeasured factors that could contribute to noted differences in perceived vision function. However, the MACS benefits from an internal comparison group of HIV− men recruited from a similar population of MSM, lessening the potential for confounding. However, the MACS also represents a unique group of MSM who are long-term survivors of HIV receiving HIV care. Other HIV+ aging populations, including women and non-MSM minorities may have less access to effective HIV treatment than the MACS cohort but also less long-term exposure to earlier therapies and HIV viremia, factors which could potentially affect perceived vision difficulties and relationships with functional outcomes. It should be noted that findings were not compared to the general (HIV-negative, non-MSM) population.

In conclusion, this study found a high burden of perceived vision difficulty in this cohort of older MSM, with the larger burden occurring among HIV+ men. Reported difficulty performing vision-dependent tasks was associated with the risk of depression and limitations of physical function, suggesting a need for vision screening in this population.

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