HHS Public Access

Author manuscript

Aging Ment Health. Author manuscript; available in PMC 2017 March 01.

Published in final edited form as:

Aging Ment Health. 2016 March ; 20(3): 295–302. doi:10.1080/13607863.2015.1008985.

Longitudinal Relationships between Visual Acuity and Severe Depressive Symptoms in Older Adults: The Salisbury Eye Evaluation Study

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Abstract

Objectives—To assess the longitudinal relationship between visual acuity (VA) and depressive symptoms (DS) among older adults.

Methods—A population-based sample of 2,520 white and black individuals aged 65–84 years in 1993–1995 were assessed at baseline and at two, six, eight years later. Presenting and best-corrected visual acuity were assessed using ETDRS chart. Depressive symptoms were assessed using the Severe Depression subscale of GHQ-28. Latent Growth Curve models estimated visual acuity and depressive symptom trajectories and age-adjusted associations between trajectories.

Results—Best-corrected logMAR VA worsened over time (slope=0.026, intercept=0.013, both $p<0.001$). No change in DS over time was observed (slope=−0.001, $p=0.762$; intercept=1.180, $p<0.001$). However, a small change in DS was observed in participants who completed all rounds (slope=0.005, $p=0.015$). Baseline VA levels correlated with baseline DS levels ($r=0.14$, $p<0.001$). Baseline DS were associated with best-corrected VA change ($r=0.17$, $p=0.01$). Baseline best-corrected VA was not associated with DS change ($r=0.017$, $p=0.8$). Best-corrected VA change was not significantly associated with depressive symptom change ($r=-0.03$, $p=0.7$).

Discussion—Depressive symptoms are significantly associated with visual acuity cross-sectionally, and persons with higher baseline DS scores were more likely to experience worsening VA over time. The complex relationship between visual impairment and DS suggests the need for

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Conflict of Interest: None of the authors of this manuscript had any potential conflicts of interest, including relevant financial interests, activities, relationships, and affiliations to disclose.

a continued effort to detect and treat both visual decline and severe depressive symptoms in a growing elderly population.

Keywords

Severe depressive symptoms; visual acuity; visual impairment; longitudinal relationship

INTRODUCTION

Low vision affects approximately one in 28 Americans older than 40 years, and the burden of visual disabilities will increase dramatically over the coming decades due largely to the aging of the US population (The Eye Diseases Prevalence Research, 2004). The psychosocial consequences of visual impairment are broad and include social isolation, depression (Bookwala & Lawson, 2011; Burmedi, Becker, Heyl, Wahl, & Himmelsbach, 2002; Carabellese et al., 1993; Wallhagen, Strawbridge, Shema, Kurata, & Kaplan, 2001), poor well-being (Burmedi et al., 2002; Pinquart & Pfeiffer, 2011), and increased risk of suicide (Lam, Christ, Lee, Zheng, & Arheart, 2008). The cross-sectional relationship between visual impairment and depression has been reported. However, only a few studies have examined the longitudinal relationship between visual impairment and depression. Brown and Barrett using two waves of data from the American Changing Life Study 1986 and 1989 showed higher level of visual impairment was associated with more depressive symptoms over a three year period (Brown & Barrett, 2011). Chou noted self-reported visual loss was a consistent predictor of onset and persistence of depression using two-year population-based data from the England Longitudinal Study of Aging (Chou, 2008). Of interest, using a clinical measure of visual acuity and data from a large French epidemiological study with up to 10 years follow-up, Carrière et al found an inconsistent relationship between visual loss and depressive symptomatology (Carrière et al., 2013).

The limitations of the aforementioned studies include: 1) using self-reported visual impairment instead of clinical measures of visual acuity, 2) evaluating the association between visual acuity and depressive symptoms over no more than three time points, 3) not simultaneously modeling depressive symptom trajectories and visual acuity trajectories and not evaluating the associations between trajectory slopes. To our knowledge, no studies have examined the longitudinal relationship between clinically measured visual acuity and depressive symptoms of the elderly over multiple time points in a multivariate latent growth curve context.

Using longitudinal data from the Salisbury Eye Evaluation (SEE) study, the purpose of this study is to describe the visual acuity and depressive symptom trajectories occurring over time among aging adults and to estimate the relationships among the trajectories. An association between trajectory slopes would provide stronger support for a relationship than cross-sectional studies since it implicitly controls for unmeasured person characteristics that are relatively static. The hypothesis of this study is that declining vision is associated with an increase in depressive symptoms in older adults over time.

METHODS

Subjects

The Salisbury Eye Evaluation study is a population-based prospective cohort study of age-related eye diseases of non-institutionalized individuals that took place from 1993 to 2003. Previous studies have described the SEE population (Munoz et al., 1999; Rubin et al., 1997). Briefly, the sample was selected from the Health Care Financing Administration Medicare eligibility list and included individuals, between age 65 and 84 years as of July 1, 1993, living in Salisbury, Maryland. The sample included 100% of identified black residents and a random age-stratified sample of 58% of identified white residents. Eligible patients had to score greater than a 17 on the Mini-Mental State Exam (MMSE) and able to travel to the clinic for a complete exam. Of those who were eligible, 65% participated. There were 2,520 participants in the initial cohort, who were re-assessed two, six, and eight years later. There were 2,240 second-round participants (1995–1997), 1,504 third-round participants (1999–2001), and 1,250 fourth-round participants (2001–2003) with over half of the loss between rounds being due to death. Informed consent was obtained in accordance with the Declaration of Helsinki and the Joint Community of Clinical Investigation at Johns Hopkins University approved the study. The University of Miami Institutional Review Board approved our study.

Visual Acuity

Visual acuity was assessed using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart, and ETDRS refraction was performed on participants worse than 20/30 using a forced-choice procedure. Visual acuity was obtained under normal luminance with illuminated ETDRS chart (Lighthouse illuminated box). Presenting and best-corrected binocular distance visual acuity was converted to logarithm of the minimum angle of resolution (LogMAR).

Depressive Symptoms

Severe depression was assessed using items from the seven-item General Health Questionnaire (GHQ-28) Part D subscale (Goldberg & Hillier, 1979). The questions were: Have you recently -- 1) thought that you might do away with yourself; 2) felt that life is entirely hopeless; 3) felt that life isn't worth living; 4) felt at times you couldn't do anything because nerves were too bad; 5) found that the idea of taking your own life kept coming to your mind; 6) found yourself wishing you were dead and away from it all; 7) been thinking of yourself as a worthless person. Each question had four possible answers with corresponding values as: 1=not at all; 2=no more than usual; 3=rather more than usual; 4=much more than usual. Severe depressive symptom score is the average of the scores of the answers to the above seven questions (sum of the scores divided by seven). The medians and interquartile ranges of visual acuity and depressive symptoms are reported in Table 1.

Covariates

The following variables were controlled in the full model: age, gender, race, education, BMI, smoking status and 15 medical conditions. Education was designated as the highest

grade completed ranging from 0 to 17. BMI was categorized as normal (reference BMI 18.5–<25), underweight (BMI<18.5), overweight (BMI 25-<30), obese (BMI 30–35), or very obese (BMI>35). Smoking status was categorized as current smoker, past smoker, or non-smoker. The 15 medical conditions were from self-reported responses to the question "Has a doctor ever told you that you have…?" and include: diabetes, stroke, heart disease, high blood pressure, cancer, asthma, arthritis, angina, back problem, broken hip, congestive heart failure, claudication, emphysema, Meniere's disease and Parkinson's disease. All control variables used in the models were measured at the baseline assessment.

Statistical Analysis

First, linear trajectory models were estimated separately for visual acuity and depressive symptoms. The models were mixed- or random-effects models estimated in the latent growth curve framework (Bollen & Curran, 2006). These models provide the following for each outcome: 1) average level at baseline (the intercept), 2) average annual change between baseline and the last assessment (the slope), 3) inter-individual variation in baseline levels (random intercept), and 4) inter-individual variation in changes over time (random slope). Trajectories for both the best-corrected visual acuity measure and the presenting visual acuity measure were estimated.

Next, visual acuity and depressive symptoms trajectory models were combined into one model and estimated simultaneously to assess the association between the visual acuity trajectories and the depressive symptom trajectories. Two separate models were evaluated. One model used the best-corrected bilateral visual acuity trajectory and the other used presenting bilateral acuity trajectory. The parameters estimated include the correlations between the baseline values, the correlations between baseline values and slopes, and the correlations between the slopes. The models first controlled for age and then controlled for all covariates outlined above. The association estimates were obtained from a multivariate trajectory model. In this model, we simultaneously estimate the two trajectories each with a fixed and random intercept and slope (i.e., 4 fixed effects and 4 random effects). This is therefore a model for a system of two equations where the random effects are allowed to correlate across the equations. The analyses were also performed in the subset of participants who completed all four rounds of the study. This was undertaken because attrition was mainly due to death and/or moving to a care facility and potentially not missing at random with respect to depressive symptoms and visual acuity. Results from this analysis may better generalize to the population of healthier elderly.

All models were evaluated using model fit statistics including the χ^2 test of model fit, which indicates a good fit if the p-value is not statistically significant. However, with larger sample sizes, the χ^2 value is often statistically significant even with small deviations in replication of the data. Other fit statistics were included that overcome this problem, including the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) for which values above 0.90 show good fit and values above 0.95 show excellent fit. A final measure, the Root-Mean-Square-Error of Approximation (RMSEA), was used for which values less than 0.10 indicate good fit and less than 0.05 indicate excellent fit. Table 2 presents the fit statistics for the models.

We included all individuals from the study in the analysis whether or not they had missing items during the study. Maximum likelihood for missing data (full information ML) estimation was used to obtain estimates in the presence of missing data (Arbuckle, 1996). The outcomes for depressive symptoms and both visual acuity measures were non-normally distributed. Because of this we used a sandwich estimator for the standard errors that is robust to non-normality (White, 1982; Yuan & Bentler, 2000). The test statistics for model fit were also adjusted to accommodate non-normality (Yuan & Bentler, 2000). Analyses were conducted using the SAS 9.3 (SAS, 2010) and Mplus 7.0 software packages (Muthén & Muthén, 1998–2007).

RESULTS

There were 2,520 study participants at the baseline, 42% men, 58% women, 74% White, and 26% African American (Table 1). The mean age was 73.5 years with standard deviation of 5.1. In this population, 52% had less than high school and 28% had above high school education. The median depressive symptom score at baseline was 1.00 with interquartile range (IQR) of 0.143, the median best-corrected visual acuity was −0.022 logMAR (IQR 0.157), and the median presenting visual acuity was 0.00 logMAR (IQR 0.194). There were 1,250 participants who completed all 4 rounds of the study. Of the total attrition of 1,270 participants by the final round, 644 (50.7%) died; 9.1% moved to nursing home; 29.1% refused to participate further in the study; 9.4% moved out of area and 1.7% were unable to be located. Participants who completed all rounds were slightly younger than those who were attritional (mean age 72.2 vs. 74.8 years, $p<0.001$), had better visual acuity at baseline (mean best-corrected visual acuity logMAR −0.02 vs. 0.04, $p<0.001$), and had lower depressive symptom scores at baseline (mean depressive symptom score 1.13 vs. 1.23, $p<0.001$).

Trajectory Models

All three of the trajectory models had adequate to good fit to the data (Table 2). The fixed and random intercept and slope estimates for visual acuity and depressive symptom trajectories are presented in Table 3. The intercepts (average baseline values) for best-corrected visual acuity and presenting visual acuity were 0.013 ($P<0.001$) and 0.040 ($P<0.001$), respectively. The slope (average biannual change) for best-corrected visual acuity and presenting visual acuity were 0.026 ($P<0.001$) and 0.022 ($P<0.001$), respectively (Table 3). Increasing values of visual acuity loss or a positive slope was observed, indicating worsening visual acuity as this population aged. The increases over time for best-corrected visual acuity loss were slightly steeper than for presenting visual acuity loss. The annual declines in best-corrected visual acuity and presenting visual acuity were 0.013 and 0.011 logMAR, respectively, which is an annual loss of less than 1 letter on the ETDRS acuity chart or close to one line over 8 years.

The intercept of the depressive symptom trajectory was statistically significant (intercept=1.18, $P<0.001$) and was equivalent to GHQ depressive symptom answers averaging between ‘not at all’ and ‘no more than usual’. However, the slope of the DS trajectory was not significant (slope=−0.001, $P=0.76$), indicating no change of depressive

symptoms on average over the study period. However, inter-individual differences in depressive symptom changes over time (slope variance) were observed.

A depressive symptom trajectory was also fitted for the subset of participants who completed all four rounds of the study. In this group, the intercept of the depressive symptom trajectory was 1.13 (P<0.001) and the slope was 0.005 (P=0.015). Unlike the depressive symptom trajectory for all participants, a small but statistically significant average change in depressive symptom trajectory was observed in this subgroup. This indicates depressive symptom worsened slightly for participants who were relatively younger and healthier at baseline and completed all rounds of the study. The change corresponds to about 0.5% increase in GHS score biannually (Table 3).

Alternate Depressive symptom Trajectory Models

To further investigate the stability of depressive symptoms in this population, analyses were performed in the subset of participants whose baseline vision were better than 20/40, those whose baseline vision were worse than 20/40, and those whose visual acuity declined substantially (individual visual acuity trajectory slope > 1.5) over the study period. In all three cases after adjustment for age there was no significant change in depressive symptoms over time (results not shown). We also utilized other GHQ questions that assess the less severe spectrum of mental distress and created a latent measure called ‘mental’. These questions included: 1) felt on the whole you were doing things well; 2) being able to enjoy your day to day activity; 3) you are playing a useful part in things; and 4) felt life is entirely hopeless. We found that the intercept of the mental trajectory was statistically significant but not the slope which was flat (intercept=1.851, P< 0.001; slope=0.002, P=0.518, respectively), providing additional evidence of the stability of depression-like symptoms in this cohort.

Trajectory Associations

Controlling for age, both best-corrected and presenting visual acuity at baseline correlated with severe depressive symptoms at baseline (r=0.141 and 0.140 respectively, P<0.001; Table 4), indicating cross-sectional relationships between visual acuity and depressive symptom at the beginning of the study. Depressive symptoms at baseline were associated with both best-corrected and presenting visual acuity change over time (r=0.170 and 0.144, P<0.01) demonstrating participants with worse depressive symptoms at baseline had worse vision decline over time. This implies that being a standard deviation higher in depressive symptom levels at the beginning of the study is associated with a 0.17 and 0.14 standard deviation larger average biennial decline in visual acuity. Neither visual acuity at baseline nor visual acuity change over time were associated with depressive symptom change over time (p-values >0.1) (Table 4).

The correlation analysis was also performed for those who completed all rounds of study. Controlling for age, both best-corrected and presenting visual acuity were correlated with depressive symptoms at baseline (r=0.178 and 0.163, p<0.01). Depressive symptoms at baseline were borderline associated with best-corrected visual acuity change over time (r=0.099, p=0.058) but not associated with presenting visual acuity change over time

(r=0.087, p=0.093) for those who completed all round of study. Neither visual acuity at baseline nor visual acuity change over time were associated with depressive symptom change over time (p-values >0.1) for those who completed all rounds of study (Table 4 part b). Participants who completed all rounds experienced a slight worsening of depressive symptom as they aged. However, in this relatively healthy subgroup of older adults, declining in visual acuity was not associated with worsening in depressive symptoms, as measured by the GHQ-28 depression subscale.

After adding all control variables to the model, the results were similar to the results from the models controlling for age only, both for all participants and for those who completed all four rounds of the study (Table 5).

DISCUSSION

To our knowledge, this is the first study to investigate the longitudinal relationship between visual acuity and severe depressive symptom using four time points. Consistent with previous research we found a significant cross-sectional relationship between visual acuity and depressive symptoms (Brody et al., 2001; Evans, Fletcher, & Wormald, 2007; Scott, Schein, Feuer, Folstein, & Bandeen-Roche, 2001). We also found persons who experienced worsening visual acuity over time were more likely to have higher depressive symptom scores at baseline. The results of our study indicate that change in visual acuity was not associated with change in depressive symptoms in this cohort. These results suggest that although these two variables are correlated, the decline in a person's vision may not be associated with worsening of severe depressive symptoms as measured by the GHQ-28 depression subscale in older people.

Depressive symptoms remained relatively stable over time in this population-based cohort with the depressive symptom trajectory staying flat over the eight year study period. Only in the subgroup of 1,250 participants who completed all four rounds of the study, was there a small but statistically significant worsening in depressive symptoms detected. These were the relatively healthy older adults who survived through the study and were well enough to reside in non-institutionalized community settings. Although statistically significant, the slight worsening in depressive symptoms was not likely to be of clinical significance for most SEE study participants. Furthermore, declining visual acuity was not associated with worsening in depressive symptoms in this subgroup. Of interest, further post-hoc analyses to investigate the stability of severe depressive symptoms in this population in those with worse baseline visual acuity and in those with more substantial visual acuity decline also showed no change in depressive symptoms over time. Utilization of other GHA questions that may assess a less severe spectrum of mental distress also showed no change in depressive symptoms over time in this population.

The reason decline in visual acuity is not associated with worsening in depressive symptoms in older adults in this study may be influenced by several factors. One possible explanation is that older adults may accept visual decline as a part of expected aging and may adapt to visual decline adequately to avoid worsening of depressive symptoms. Severe depression was rare in this community-based older adult population with a mean GHQ score of 1.18

and a median score of 1 which corresponds to a GHQ severe depression answer of ‘not at all’. The level of depressive symptoms of most older adults remains relatively stable over time (Phifer & Murrell, 1986). These could contribute to the lack of longitudinal association between visual acuity and depressive symptoms. One of the inclusion criteria for the study required participants to score above 17 on the Mini Mental Status Exam (MMSE). Therefore, the study included only adults with good cognitive function at baseline; elders with severe depression may have been excluded from the study due to this selection criterion (Ganguli, Du, Dodge, Ratcliff, & Chang, 2006; Yaffe et al., 1999). Moreover, some participants refused to participate further in the study or moved into assisted living facilities. Whether depressive symptoms increased over time within this subset of the cohort is unknown. To study the influence of depressive symptoms and visual acuity on attrition, ordinal logistic regressions were performed with follow up status as the outcome and depressive symptoms and visual acuity as the predictor, respectively, while controlled for age, gender, race and education in the model. Results indicate that those with worse depressive symptoms or worse visual acuity were more likely to die, refuse to participate further or move to nursing home (results not shown). Therefore, attrition could contribute to the lack of change in the depressive symptom trajectory and consequently, the lack of association between the change in visual acuity and change in depressive symptoms.

The life course perspective on the epidemiology of depression is important to consider in evaluating the change in depressive symptoms and the factors that affect depression. Colman and Ataulluhjan maintain that a number of interrelated factors affect depressive symptom outcomes over the course of a lifetime, starting from *in utero* and extending through adolescence and into adulthood (Colman & Ataullahjan, 2010). Factors such as genetics, parental support, and comorbidities along with traumatic life events such as unemployment and loss-related events all influence one another and in turn the ultimate outcomes of depressive symptomatology. Thus, estimating the effects of visual acuity changes on the change in depressive symptom becomes more complex, as we did not include time variant factors that may have influenced associations between changes in vision and depressive symptoms (i.e., increase in loss-related events).

Although the estimated relationship between a change in visual acuity and a change in depressive symptom was minimal ($r=-0.027$, $P=0.719$), there was a correlation between baseline depressive symptoms and a change in visual acuity over time ($r=0.17$, $P<0.001$). This result implies that depression may have an adverse effect on visual acuity, and older adults with depression could experience worse vision decline. A possible explanation for this result is that individuals who suffer from depression may be less likely to seek ophthalmic care (i.e., for a cataract or refractive error). Additionally, depression is associated with behaviors that may increase eye disease such as poor diet, which has been suggested as a potential explanation for the relationship between baseline depression and changes in vision (Glynn, Rosner, & Christen, 2009). In the elderly, it has been shown that baseline depressive symptoms are associated with an increase in visual function loss, another assessment of visual impairment measured as the inability in recognizing a face at four meters (Carrière et al., 2013).

Although this study did not find strong evidence for the role that declining vision may play increasing the risk of depressive symptoms, other SEE study findings indicate that increased risk of mortality associated with vision loss is mediated thru the declines in Instrumental Activities of Daily Living (IADL).(Christ et al., 2014) Declining IADL may also result in a complex cascade of interacting adverse effects that increase mortality risk, including increases in social isolation, loneliness and declines in physical activity levels.(House, Landis, & Umberson, 1988; Perissinotto, Stijacic Cenzer, & Covinsky, 2012; Tilvis, Laitala, Routasalo, & Pitkala, 2011) For example, loneliness increases symptoms of depression; even after accounting for depression, loneliness can increase mortality.(Luo, Hawkley, Waite, & Cacioppo, 2012) Adding to this, depression is a known predictor of loneliness in older adults and this is partly due to deterioration in physical mobility.(Bowling, Edelmann, Leaver, & Hoekel, 1989) This loneliness-mortality relationship can be further explained by the fact that lonely older adults are less likely to engage in physical activity (Hawkley, Thisted, & Cacioppo, 2009) and an inverse relationship between physical activity and mortality exists.(Kokkinos et al., 2010) The strengths of the study include: 1) the study was prospective and population based, observing older adults in multiple time points over an 8 year period, 2) vision was measured clinically, and 3) the longitudinal relationship of visual acuity and depressive symptoms was examined in the latent growth curve framework. The limitations of this study include the GHQ-28 Depression subscale which tends to capture severe depressive symptoms and may be less sensitive to mild depressive symptoms. Secondly, we were unable to access the extent attrition may have affected the relationship between visual acuity and depressive symptoms. Thirdly, the data from the SEE Study was collected from 1993 to 2003 and therefore may not represent current medical conditions in the US older population.

In summary, this study adds to the literature by suggesting that baseline depressive symptoms may have an effect on changes in visual acuity over time. However, we were unable to show that declining in vision was associated with worsening of depressive symptoms as measured by the GHQ-28 depression subscale in older people. Overall, the complex relationship between visual impairment and depressive symptoms suggests the need for a continued effort to detect and treat both visual decline and severe depressive symptoms in a growing elderly population. Further longitudinal studies with inclusion of other visual measures such as visual field as well as assessment of mild to severe depressive symptoms will improve the understanding of the relationship between changes of vision and depressive symptoms. Comprehensive follow-up of these parameters including those participants who move to assisted facilities and nursing homes will assist in the understanding of the role of visual and depressive symptom changes on major life transitions in the elderly.

Acknowledgements

All authors participated in the interpretation of findings, in manuscript development, and editing. Sheila West and Beatriz Munoz were involved in the original design and collection of SEE data.

Funding: This work was supported by National Eye Institute (EY21187), which provided funding for this study including linkage of SEE participants with the National Death Index and analyses of data. Support for the original collection of SEE data was provided by National Institute on Aging Grant (AG10184).

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Table 1

Demographic Characteristics, Visual Acuity, and Depressive Symptoms of the Study Population at each round of the study

	Round 1	Round 2	Round 3	Round 4
Total (n)	2520	2240	1504	1250
Average age (SD)	73.5(5.1)	75.2(5.0)	78.2(4.7)	79.8(4.6)
Gender				
Male	1062 (42%)	927 (41%)	618 (41%)	501 (40%)
Female	1458 (58%)	1313 (59%)	886 (59%)	749 (60%)
Race				
White	1854 (74%)	1660 (74%)	1135 (75%)	956 (76%)
Black	666 (26%)	580 (26%)	369 (25%)	294 (24%)
Education				
Less than High school	1299 (52%)	1131 (51%)	723 (48%)	597 (48%)
High School Graduate	514 (20%)	454 (20%)	314 (21%)	259 (20%)
Above High School	707 (28%)	655 (30%)	467 (31%)	394 (32%)
Median Depressive Symptoms	1.00	1.00	1.00	1.00
IQR* Depressive Symptoms	0.143	0.143	0.142	0.143
Median Presenting visual acuity	0	0.02	0.041	0.021
IQR* Presenting visual acuity	0.194	0.201	0.192	0.176
Median Best Corrected visual acuity	−0.022	0.021	0.021	0.021
IQR* Best Corrected visual acuity	0.157	0.167	0.143	0.142

* IQR – Inter Quartile Range

Table 2

Model Fit Statistics for Linear Trajectory Models and the Full Model

Models	Chi sq	df	p-value	CFI	TLI	RMSEA
Depressive symptom trajectory	4.94	5	0.42	1	1	0
Best corrected visual acuity trajectory	46.03	5	<0.001	0.967	0.961	0.057
Presenting visual acuity trajectory	50.23	5	<0.001	0.967	0.961	0.06
Correlation of DS and best corrected VA trajectories controlled for age	69.26	26	<0.001	0.987	0.981	0.026
Correlation of DS and presenting VA trajectories controlled for age	68.82	26	<0.001	0.987	0.982	0.026
Correlation of DS and best corrected VA trajectories controlled for all covariates	175.07	122	0.001	0.99	0.982	0.013
Correlation of DS and presenting VA trajectories controlled for all covariates	178.22	122	<0.001	0.989	0.98	0.014

Table 3

Intercept and Slope Estimates of Depressive Symptom and Visual Acuity Trajectories

Models	Intercept	S.E.	Intercept Variance	S.E.	Slope	S.E.	Slope Variance	S.E.
All Participants (n=2520)								
Trajectory of Depressive Symptoms	1.184***	0.007	0.076***	0.007	−0.001	0.002	0.002***	0.001
Trajectory of best corrected visual acuity (logMAR)	0.013**	0.004	0.033***	0.004	0.026***	0.002	0.002***	0.000
Trajectory of Presenting visual acuity (logMAR)	0.04***	0.004	0.038***	0.004	0.022***	0.002	0.002***	0.000
Participants in all rounds of study (n=1250)								
Trajectory of Depressive Symptoms	1.132***	0.007	0.049***	0.007	0.005*	0.002	0.002***	0.001
Trajectory of best corrected visual acuity (logMAR)	0.021***	0.004	0.017***	0.002	0.023***	0.001	0.002***	0.000
Trajectory of Presenting visual acuity (logMAR)	0.004	0.004	0.021***	0.003	0.02***	0.002	0.002***	0.000

* p<0.05;

** p<0.01;

*** p<0.001

Table 4

Correlation for VA and DS Trajectories Controlled for Age (a–b)

a) All participants (n=2520)				
	Depressive Symptoms at Baseline	**P value**	**Depressive Symptoms Change**	**P value**
Best-Corrected VA at Baseline	0.141	<0.001	0.017	0.806
Best-Corrected VA Change	0.170	0.001	−0.027	0.719
Presenting VA at baseline	0.140	<0.001	0.005	0.937
Presenting VA Change	0.144	0.007	0	0.995

b) Those who were in all rounds of study (n=1250)				
	Depressive Symptoms at Baseline	**p value**	**Depressive Symptoms Change**	**p value**
Best-Corrected VA at Baseline	0.178	0.001	−0.001	0.99
Best-Corrected VA Change	0.099	0.058	0.066	0.34
Presenting VA at baseline	0.163	0.001	0	0.998
Presenting VA Change	0.087	0.093	0.074	0.287

Table 5

Correlation for VA and DS Trajectories Controlled for all Covariates*

All participants (n=2520)				
	Depressive Symptoms at Baseline	**P value**	**Depressive Symptoms Change**	**P value**
Best-Corrected VA at Baseline	0.101	0.001	0.027	0.696
Best-Corrected VA Change	0.146	0.007	−0.033	0.663
Presenting VA at Baseline	0.101	0.001	0.019	0.772
Presenting VA Change	0.118	0.03	−0.009	0.91
Those who were in all rounds of study (n=1250)				
	Depressive Symptoms at Baseline	P value	Depressive Symptoms Change	P value
Best-Corrected VA at Baseline	0.137	0.011	0.006	0.929
Best-Corrected VA Change	0.087	0.103	0.057	0.402
Presenting VA at Baseline	0.129	0.009	0.009	0.894
Presenting VA Change	0.07	0.186	0.061	0.374

*list of covariates: age, gender, race, education, BMI, smoking status and 15 medical conditions that include: diabetes, stroke, heart disease, high blood pressure, cancer, asthma, arthritis, angina, back problem, broken hip, congestive heart failure, claudication, emphysema, Meniere's disease and Parkinson's disease