Is there an association between self-reported physical activity and self-rated vision over time? Results from the TILDA study.

Abstract

Research suggests that physical activity has many health benefits for an ageing population. Evidence exploring the association between physical activity (PA) and vision is limited. This study includes the measures of self-reported PA (IPAQ) and self-rated vision at three points in time over a six-year period used in the TILDA study, a cohort of community-dwelling older adults (50 years or over). A path analysis found that PA was indirectly associated with vision over six years controlling for age, sex, marital status, employment, education, depression (CES-D), self-reported general health, CVD (e.g. heart attack), high blood pressure, diabetes, eye disease (e.g. glaucoma, diabetic eye disease, macular degeneration, cataract), and disabilities associated with activities of daily living (ADLs). Further research is needed to fully understand the relationship over time and generalise the findings.

Key words

Vision impairment; longitudinal; path analysis; subjective measures.

Introduction

Globally 285 million people are living with a form of visual impairment (VI), either the partial or complete loss of sight in one or both eyes (WHO, 2019). In the UK, statistics suggest that approximately two million people are living with VI of which approximately 80% are aged 60 years or over due to disease or degeneration from the ageing process (WHO, 2019). People with a disability experience health disparity in comparison to the general population (WHO, 2011), where people with VI have a higher risk of poorer general health (DoH, 2011). Research suggests that older adults with VI have an increased risk of obesity which is a key risk factor for chronic diseases such as a heart disease, diabetes and stroke (Jones et al., 2009). Consequently, addressing risk factors in older adults with VI is an important health concern (DoH, 2011; WHO, 2011).

The health benefits of physical activity (PA) in older adults are well established (Bangsbo et al., 2019). Despite such benefits, less than 10% of those over 55 years meet the guidelines for PA for health (30 minutes of at least moderate physical activity on five or more days per week), and 75% of older adults spend their waking time being sedentary (Arnardottir et al., 2013; Harvey et al., 2015). Additionally, the PA levels of older adults with VI are lower than older adults without (Rimmer & Marques, 2012), and research suggests that older adults with a sensory impairment like vision or hearing loss have 4% lower PA levels than those with any other impairment such as spinal cord injury (Ong et al., 2018; Sport England, 2011). Barriers to PA adherence in older adults include lack of awareness or belief in the benefits of PA, fear regarding personal security, lack of time, lack of social support, lack of interest, as well as environmental issues such as the weather or lack of appropriate facilities (Baert et al., 2011; Cavill & Foster, 2018; Chao et al., 2000; Franco et al., 2015; Schutzer & Graves, 2004). Older adults with VI face additional barriers to PA such as a self-consciousness about exercising in public; the perception that exercise is too difficult due to their disability; as well as environmental barriers such as lack of

access to appropriate places for exercise, lack of availability of appropriate exercise equipment, unqualified staff, programme and equipment costs, and discriminatory practices at fitness centres and other recreational venues (Rimmer & Marques, 2012).

However, research exploring the relationship between PA and vision is limited in older adults with VI. In the main, studies have been cross-sectional, concluding that older adults with VI (mean age 65 years) were less physically active than those with normal vision (mean difference −82.8 min/week, 95% CI: −147.8 to −17.8) (Smith et al., 2016; n=6634 participants); that younger adults (20-59 years) with VI were less physically active taking 26% fewer steps per day and spending 48% less time in MVPA than those with normal sight (Willis et al.; 2012; n=5722 participants); and that children and adolescents (6-20 years) with VI had more sedentary lifestyles than those without VI (Longmuir & Bar-Or, 2000). Additionally, cross-sectional research has focused on socio demographic factors such as sex, concluding that sex is an important predictor of PA in adults with VI (Haegele et al., 2016; n=176 participants), where females with VI (20–49 years old) are more sedentary than those with normal vision (mean difference 329.8 min/week, 95% CI: 12.5 to 647.0) (Smith et al., 2019; n=6001 participants). Although these studies can provide an indication of the correlation between PA and vision, they do not explore the association between PA and VI over time, and so limits the interpretation of causality (Schmidt et al., 2017).

This study aims to understand the association between self-reported PA and self-rated vision in a large population-based cohort study of older adults to extend our understanding of the relationship over time. The questions addressed were: (1) what changes occur in self-reported PA and self-rated vision over a 6-year period in older adults? (2) what is the relationship between self-reported PA and self-rated vision over a 6-year period in older adults? and (3) what are the key risk factors for self-reported PA and self-reported vision over a 6-year period?

Methods

Participants

TILDA is an ongoing cohort study of ageing that includes community-dwelling older adults (≥50 years) in the Republic of Ireland (RoI) (Kearney, Cronin and O'Regan, 2011). TILDA adheres to the Gateway to Global Ageing Initiative which globally harmonises data collection across longitudinal studies of ageing. In brief, the sampling frame used in TILDA was the Irish Geodirectory, a listing of residential addresses from which a clustered sample of addresses was chosen and stratified according to area level socioeconomic status and geographical location. Addresses were selected within each geographic cluster, and all household residents ≥50 years along with their spouses/partners were eligible to participate (Kearney et al., 2011). Data collection included (i) a computer-assisted personal interview (CAPI); (ii) a self-completed questionnaire; and (iii) a detailed health assessment. This study uses data from wave 1 (2009), wave 2 (2013), and wave 3 (2015). In total, the household response rate was 62% (8504 participants) for wave one, 86% (7455 participants) for wave two, and 62% (6279 participants) for wave three.

The data were provided free of charge through an online application process for the purposes of this analysis by the Irish Social Science Data Archive (ISSDA) at University College Dublin (http://www.ucd.ie/issda/data/tilda/) and the Interuniversity Consortium for Political and Social Research (ICPSR) at the University of Michigan (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34315). Ethical approval for TILDA was obtained from the Trinity College Dublin Research Ethics

Exposure: self-rated vision

To assess self-rated vision, participants were asked 'Is your eyesight (using glasses or corrective contact lenses) excellent, very good, good, fair, or poor?'

Outcome: self-reported physical activity

The International Physical Activity Questionnaire (IPAQ) (short form), a validated measure of PA was used to assess PA levels (Craig et al., 2003; Hallal et al., 2012). IPAQ is a self-reported measure of time spent on different activity levels (vigorous/moderate/walking) over the last seven days. The time spent on activity level is weighted based on energy requirement giving a total number of Metabolic Equivalent for Task (MET) minutes per week (the ratio of the rate of energy expended during an activity to the rate of energy expended at rest).

Covariates

Demographic measures of age, sex, marital status, employment, and education were self-reported.

Health and lifestyle measures included depressive symptoms (using the eight-item Centre for Epidemiological Studies Depression Scale; CES-D), self-reported general health, history of CVD (e.g. heart attack), history of high blood pressure, history of diabetes and history of eye disease (e.g. glaucoma, diabetic eye disease, macular degeneration, cataract). Disabilities were assessed based on participant's responses to interviewers' questions on perceived difficulties in six basic activities of daily living (ADLs), such as difficulty dressing, walking across a room, bathing or showering, eating, getting in or out of bed, and using the toilet.

Analysis

Characteristics of the study population were summarised using descriptive statistics.

To investigate the longitudinal associations between self-rated vision and self-reported PA over three waves of data (across six years) adjusted for prespecified covariates based on existing

literature, a path-analysis within the framework of structural-equation-modelling was used (Figure 1).

Model fit was evaluated using a Root Mean Square Error of Approximation (RMSEA) ≤0.05 with an upper limit (90% CI) ≤0.08; a Comparative Fit Index (CFI) ≥0.95; a Tucker Lewis Index (TLI) ≥0.95; and a Standardised Root Mean Square Residual (SRMR) ≤0.08 (Hoyle, 1995). Where the levels of fit indices were not achieved, the modification indices were examined, and where appropriate, adjustments were made. Statistical significance was set at $p<0.05$. A high estimate (Est) indicates a strong effect/relationship, whilst a low estimate indicates a weaker effect/relationship. All analysis was conducted in Mplus (version 7.4; Muthen & Muthen, Los Angeles, CA).

Maximum likelihood estimation with robust standard errors (MLR) was used and is robust to non-normality (Enders, 2013; Yaun & Bentler, 2000). Missing data were assumed to be missing at random where systematic differences between the missing and observed values are assumed to be explained by other observed variables (Schafer & Graham, 2002). MLR utilises a model-based strategy for dealing with missing data which enables all participants to be included in analysis.

Results

Descriptive statistics are shown in Table 1. In brief, the sample analysed in this study consisted of 8255 participants (mean age 63.57 years; 55% female; 68% married). 36% of participants suffered from high blood pressure; 37% had heart disease; 7% had diabetes; 12% had a disability; and 84% had a history of eye disease.

The model described the data well where fit statistics showed Root Mean Square Error of Approximation ≤0.05 (RMSEA=0.01) (with an upper limit ≤0.08 (90% CI=0.01, 0.02); a

Comparative Fit Index ≥0.95 (CFI=0.99); a Tucker Lewis Index ≥0.95 (TLI=0.98); and a Standardised Root Mean Square Residual ≤0.08 (SRMR=0.04) (Hoyle, 1995).

The results from the path analysis are summarised in Table 2 and are described below.

Direct effects: Self-reported PA

PA on PA (*Wave 1, 2, and 3)*

Table 2 shows that self-reported PA at wave one had a statistically significant direct effect on PA at wave two (Estimate (Est)=1.00; Standard error (SE)=0.03), where the change in PA at wave one is identical to the change in PA at wave two. Additionally, PA at wave two had a statistically significant direct effect on PA at wave three (Est=0.76; SE=0.18). However, PA at wave one did not have a statistically significant effect on PA levels at wave three (Est=-0.01; SE=-0.09).

PA did not have a statistically significant effect on self-rated vision between wave one and wave two (Est=0.00; SE=0.00); or wave two and wave three (Est=-0.02; SE=0.01). Therefore, PA has no direct effect on vision over time.

The covariates of age (Est=-0.15; SE=0.01), sex (Est=-0.21; SE=0.01), health (Est=-0.10; SE=0.01), depression (Est=-0.05; SE=0.01), high blood pressure (Est=-0.03; SE=0.01), diabetes (Est=-0.03; SE=0.01), and disability in ADL (Est=-0.06; SE=0.01) were found to be statistically significantly associated with self-reported PA, where older adults, females, those in poor health, depression, high blood pressure, diabetes, and a disability in ADL had lower levels of PA. The covariates of marriage, education, employment status, history of eye disease or CVD were not statistically significant for PA.

Direct effects: Self-rated vision

Table 2 shows that self-rated vision at wave one had a statistically significant direct effect on vision at wave two (Est=0.76; SE=0.03), but not on vision at wave three. Vision at wave two had a statistically significant effect on vision at wave three (Est=0.98; SE=0.09).

There was no statistically significant effect found for self-rated vision on self-reported PA between waves.

Self-rated vision did not have a statistically significant direct effect on self-reported PA between wave one and wave two, wave one and wave three, or wave two and wave three.

The covariates of age (Est=0.10; SE=0.01), marital status (Est=0.10; SE=0.01), employment status (Est=0.03; SE=0.01), education level (Est=-0.04; SE=0.02), health (Est=0.28; SE=0.01), depression (Est=0.09; SE=0.01), eye disease (Est=-0.16; SE=0.01), CVD (Est=0.04; SE=0.01), and disability in ADL (Est=0.03; SE=0.01) were found to be statistically significantly associated with self-rated vision, where those adults who were older, widowed, retired, with poor health, depression, no history of eye disease, CVD, or disability of ADL had poor self-rated vision. The covariates of high blood pressure and diabetes did not have a statistically significant effect on self-rated vision.

Indirect effects: Self-rated vision and self-reported PA

Indirect effects are shown in Table 3.

A statistically significant indirect relationship between PA at wave one and PA at wave three was shown via an effect of vision at both wave one and two (Est=0.76; Est=0.11) (Fig 1 path K+H G+J). This suggests that PA has an accumulative effect on PA over time via its effect on vision. However, PA at wave one does not have a statistically significant effect on vision at wave three via the effect of vision at wave two and PA at wave two (Est=-0.02; SE=-0.01) (Fig 1, path G+I+A+B).

A statistically significant indirect relationship between vision at wave one and vision at wave three was shown via the effect of vision at wave two and PA at wave two (Est=0.71; SE=0.03) (Fig 1 path A+B+D+I). This suggests that vision at wave one has an accumulative effect on vision over time via its effect on both vision and PA. However, vision at wave one does not have a statistically significant effect on PA level at wave three via the effect of vision at wave two (Est=-0.01; SE=0.03) (Fig 1 path A+H+D+J), suggesting that vision does not affect PA overtime.

Total effects: Self-rated vision and self-reported PA

Total effects are shown in Table 3.

A statistically significant relationship between PA at wave one, and PA at wave three was shown via the effect of PA on vision at both wave one and wave two, and the direct effect from PA at wave one to PA at wave three (Est=0.76; Est=0.11) (Fig 1 path K+H G+J+F). This suggests that PA has an accumulative effect on PA over time via its effect on vision. However, PA at wave one does not have a statistically significant effect on vision at wave three via the effect of vision at wave two and PA at wave 2 (Est=-0.02; SE=0.01) (Fig 1, path G+I+A+B).

A statistically significant relationship between vision at wave one and vision at wave three via its effect on vision at wave two, PA at wave two, and the direct effect on vision at wave three (Est=0.71; SE=0.03) (Fig 1 path A+B+D+I+C). This suggests that vision has an accumulative effect on vision over time via its effect on vision and PA. However, vision at wave one does not have a statistically significant effect on PA level at wave three via the effect of vision at wave two (Est=0.06; SE=0.04) (Fig 1 path A+H+D+J+E).

The results also showed that age (Est=-0.11; SE=0.02), sex (Est=-0.16; SE=0.03), health status (Est=-0.06; SE=0.02), depression (Est=-0.04; SE=0.01), high blood pressure (Est=-0.02; SE=0.01), diabetes (Est=-0.02; SE=0.01), and disabilities of ADL (Est=-0.05; SE=0.01) were significant for PA level. Older adults; females; and those with poorer self-rated health, higher

levels of depression, high blood pressure, diabetes, and a disability of ADL had low PA levels. Additionally, age (Est=0.04; SE=0.01), health (Est=0.20; SE=0.01), education (Est=-0.03; SE=0.01), employment status (Est=0.02; SE=0.01), depression (Est=0.06; SE=0.01), eye disease (Est=-0.11; SE=0.01), CVD (Est=0.03; SE=0.01), and disability of ADL (Est=0.02; SE=0.01) were significant for vision where older adults; retired; and those with poor health, lower education, depression, eye disease, CVD, and a disability of ADL had poor vision.

Education, employment status, eye disease and CVD were not statistically significant for PA level. Sex, high blood pressure, or diabetes were not statistically significant for vision.

Discussion

Summary of findings

This is one of the first studies to investigate the association between self-reported PA and self-rated vision over time using a large population of community-dwelling older adults. A statistical model was tested to investigate the hypothesis that PA mediates vision, or vision mediates PA controlling for covariates of age; marital status; sex; self-reported health; education; employment; depression; history of high blood pressure, eye disease, diabetes, and CVD; and disability of ADL. Fit statistics indicated that the model described the data well. Overall, the analysis found that PA does not directly affect vision; that vision does not directly affect PA; that PA has a cumulative effect on future PA, via its effect on vision over time; that self-rated vision has a cumulative effect on vision, via its effect on PA overtime. In addition, age, self-rated health, depression, and ADL were statistically significant for both self-reported PA and vision; marital status, employment status, education level, history of eye disease and CVD were found to be statistically significant for vision only; and sex, history of high blood pressure and diabetes were statistically significant for only PA.

This longitudinal analysis extends our understanding of the association between PA. The findings do not support that PA and vision have a direct influence on each other which contradicts existing research (Ong et al., 2018; Smith et al., 2016; 2019; Longmuir & Bart-Or, 2000; Willis et al., 2012). However, the findings suggest that there is an indirect relationship and therefore a cumulative influence over time. A possible reason for this is that older adults have low PA levels and tend to spend more time in low intensity activities (Arnardottir et al., 2013; Harvey et al., 2015). The mean age of participants in the TILDA study is 64 years and so the cohort may carry out lower intensity PA or less PA which may not be of an adequate level to elicit a direct change in vision. Further analysis should explore how different intensities of PA affect vision. Furthermore, there is a reduced number of participant responses for self-reported PA in wave three, and whilst the model uses a model-based strategy (MLR) for dealing with missing data which enables all participants to be included in analysis, there is still a substantial loss in participants.

Additionally, research suggests that the type of VI may be associated with PA level where for example, non-refractive visual problems are associated with higher sedentary behaviour than refractive visual problems (Smith et al., 2019). Whilst we know that 84% of our sample had a history of eye disease, we do not know what kind of VI is prevalent. The measure of self-rated vision also asks a very general question relating to vision. Therefore, it may be that the participants used in this study have higher levels of non-refractive visual problems and so may not carry out PA at a level that affects vision over time, this explaining the lack of direct association. We encourage future research in this area.

Strength and limitations

Whilst a strength of the cross-lagged panel model used is that it simultaneously estimates both direct and indirect associations thus exploring the reciprocal relationship between the observed variables of self-reported PA and self-rated vision using longitudinal data, it assumes factorial

invariance of the measures (Hays et al., 1994; Selig & Little, 2012). This study includes only observed, or manifest variables, and so factorial invariance is an untestable assumption in the current model. Additionally, the model includes repeated measures across time which may give rise to a retest effect, where participants react to repeated questioning in the same way or try to meet the interviewer expectations (Selig & Little, 2012). Additionally, the mean age of the TILDA study cohort is 64 years and there is a high level of eye disease (84%) reported in our sample which may bias the findings. Also, older adults are more likely to carry out lower intensity physical activity which requires a longer period of study to elicit health benefits (Bauman et al.,2016; Hoffmann et al., 2016) and so longitudinal studies including younger participants over a longer period of time (>6 years) may be needed.

Also, the model assumes that all the important predictors are included in the analysis, but there are many possible determinants of human behaviour which may potentially confound the study's findings (Selig & Little, 2012).

Consequently, the findings should be considered with caution and future research should consider including multiple measures to create a latent variable to address measurement error (Selig & Little, 2012).

In addition, the measures used are both subjective and may be influenced by health status, mood, depression, anxiety, or cognitive ability, as well as seasonal variation, social desirability, or recall issues (Dyrstad et al., 2014; Murphy, 2009; Saelens et al., 2012). Future studies should consider objective measures over time to address some of these biases (Bauman et al., 2009).

Conclusion

In this sample of community-dwelling older adults an indirect cumulative association was found between self-reported PA and vision over a 6-year period. The key risk factors for both self-reported PA and vision over a 6-year period were age, health status, depression, and disabilities

of ADL. Additionally, sex, high blood pressure, and diabetes were high risk factors for PA level, whilst education employment status, eye disease, and CVD were high risk factors for vision. Further research is needed to explore the association across time in other cohorts to be able to generalise the findings. The findings suggest that PA interventions for older adults with VI are beneficial to long-term health outcomes.

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