



Is There an Association Between Self-Reported Physical Activity and Self-Rated Vision Over Time? Results From the Irish Longitudinal Study of Ageing

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

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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.

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

1 Introduction

2 Globally 285 million people are living with a form of visual impairment (VI), either the partial or
3 complete loss of sight in one or both eyes (WHO, 2019). In the UK, statistics suggest that
4 approximately two million people are living with VI of which approximately 80% are aged 60
5 years or over due to disease or degeneration from the ageing process (WHO, 2019). People
6 with a disability experience health disparity in comparison to the general population (WHO,
7 2011), where people with VI have a higher risk of poorer general health (DoH, 2011). Research
8 suggests that older adults with VI have an increased risk of obesity which is a key risk factor for
9 chronic diseases such as a heart disease, diabetes and stroke (Jones et al., 2009).
10 Consequently, addressing risk factors in older adults with VI is an important health concern
11 (DoH, 2011; WHO, 2011).

12 The health benefits of physical activity (PA) in older adults are well established (Bangsbo et al.,
13 2019). Despite such benefits, less than 10% of those over 55 years meet the guidelines for PA
14 for health (30 minutes of at least moderate physical activity on five or more days per week), and
15 75% of older adults spend their waking time being sedentary (Arnardottir et al., 2013; Harvey et
16 al., 2015). Additionally, the PA levels of older adults with VI are lower than older adults without
17 (Rimmer & Marques, 2012), and research suggests that older adults with a sensory impairment
18 like vision or hearing loss have 4% lower PA levels than those with any other impairment such
19 as spinal cord injury (Ong et al., 2018; Sport England, 2011). Barriers to PA adherence in older
20 adults include lack of awareness or belief in the benefits of PA, fear regarding personal security,
21 lack of time, lack of social support, lack of interest, as well as environmental issues such as the
22 weather or lack of appropriate facilities (Baert et al., 2011; Cavill & Foster, 2018; Chao et al.,
23 2000; Franco et al., 2015; Schutzer & Graves, 2004). Older adults with VI face additional
24 barriers to PA such as a self-consciousness about exercising in public; the perception that
25 exercise is too difficult due to their disability; as well as environmental barriers such as lack of

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

4 However, research exploring the relationship between PA and vision is limited in older adults
5 with VI. In the main, studies have been cross-sectional, concluding that older adults with VI
6 (mean age 65 years) were less physically active than those with normal vision (mean difference
7 -82.8 min/week, 95% CI: -147.8 to -17.8) (Smith et al., 2016; n=6634 participants); that
8 younger adults (20-59 years) with VI were less physically active taking 26% fewer steps per day
9 and spending 48% less time in MVPA than those with normal sight (Willis et al.; 2012; n=5722
10 participants); and that children and adolescents (6-20 years) with VI had more sedentary
11 lifestyles than those without VI (Longmuir & Bar-Or, 2000). Additionally, cross-sectional
12 research has focused on socio demographic factors such as sex, concluding that sex is an
13 important predictor of PA in adults with VI (Haegele et al., 2016; n=176 participants), where
14 females with VI (20–49 years old) are more sedentary than those with normal vision (mean
15 difference 329.8 min/week, 95% CI: 12.5 to 647.0) (Smith et al., 2019; n=6001 participants).
16 Although these studies can provide an indication of the correlation between PA and vision, they
17 do not explore the association between PA and VI over time, and so limits the interpretation of
18 causality (Schmidt et al., 2017).

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

25

1 Methods

2 **Participants**

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

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

22 **Exposure: self-rated vision**

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

1 Outcome: self-reported physical activity

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

8 Covariates

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

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

18

19 Analysis

20 Characteristics of the study population were summarised using descriptive statistics.

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

3 Model fit was evaluated using a Root Mean Square Error of Approximation (RMSEA) ≤ 0.05 with
4 an upper limit (90% CI) ≤ 0.08 ; a Comparative Fit Index (CFI) ≥ 0.95 ; a Tucker Lewis Index (TLI)
5 ≥ 0.95 ; and a Standardised Root Mean Square Residual (SRMR) ≤ 0.08 (Hoyle, 1995). Where
6 the levels of fit indices were not achieved, the modification indices were examined, and where
7 appropriate, adjustments were made. Statistical significance was set at $p < 0.05$. A high estimate
8 (Est) indicates a strong effect/relationship, whilst a low estimate indicates a weaker
9 effect/relationship. All analysis was conducted in Mplus (version 7.4; Muthen & Muthen, Los
10 Angeles, CA).

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

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Results

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

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

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

4 Direct effects: Self-reported PA*5 PA on PA (Wave 1, 2, and 3)*

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

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

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

22 Direct effects: Self-rated vision

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

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

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

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

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

17 Indirect effects are shown in Table 3.

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

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

8 Total effects are shown in Table 3.

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

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

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

1 levels of depression, high blood pressure, diabetes, and a disability of ADL had low PA levels.
2 Additionally, age (Est=0.04; SE=0.01), health (Est=0.20; SE=0.01), education (Est=-0.03;
3 SE=0.01), employment status (Est=0.02; SE=0.01), depression (Est=0.06; SE=0.01), eye
4 disease (Est=-0.11; SE=0.01), CVD (Est=0.03; SE=0.01), and disability of ADL (Est=0.02;
5 SE=0.01) were significant for vision where older adults; retired; and those with poor health,
6 lower education, depression, eye disease, CVD, and a disability of ADL had poor vision.
7 Education, employment status, eye disease and CVD were not statistically significant for PA
8 level. Sex, high blood pressure, or diabetes were not statistically significant for vision.

9

10

Discussion

11 **Summary of findings**

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

1 This longitudinal analysis extends our understanding of the association between PA. The
2 findings do not support that PA and vision have a direct influence on each other which
3 contradicts existing research (Ong et al., 2018; Smith et al., 2016; 2019; Longmuir & Bart-Or,
4 2000; Willis et al., 2012). However, the findings suggest that there is an indirect relationship and
5 therefore a cumulative influence over time. A possible reason for this is that older adults have
6 low PA levels and tend to spend more time in low intensity activities (Arnardottir et al., 2013;
7 Harvey et al., 2015). The mean age of participants in the TILDA study is 64 years and so the
8 cohort may carry out lower intensity PA or less PA which may not be of an adequate level to
9 elicit a direct change in vision. Further analysis should explore how different intensities of PA
10 affect vision. Furthermore, there is a reduced number of participant responses for self-reported
11 PA in wave three, and whilst the model uses a model-based strategy (MLR) for dealing with
12 missing data which enables all participants to be included in analysis, there is still a substantial
13 loss in participants.

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

22 **Strength and limitations**

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

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

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

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

21 **Conclusion**

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

PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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

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PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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PHYSICAL ACTIVITY AND VISION IN OLDER ADULTS

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