PLOS ONE

RESEARCH ARTICLE

Vision impairment and associated daily activity limitation: A systematic review and meta-analysis

Masoud Rahmati[1,2,3]*, Lee Smith[4], Laurent Boyer[1], Guillaume Fond[1], Dong Keon Yon[5,6], Hayeon Lee[5], Tarnjit Sehmbi[7], Mapa Prabhath Piyasena[7], Shahina Pardhan[7,8]*

1 AP-HM, Research Centre on Health Services and Quality of Life, Aix Marseille University, Marseille, France, **2** Department of Physical Education and Sport Sciences, Faculty of Literature and Human Sciences, Lorestan University, Khoramabad, Iran, **3** Department of Physical Education and Sport Sciences, Faculty of Literature and Humanities, Vali-E-Asr University of Rafsanjan, Rafsanjan, Iran, **4** Centre for Health, Performance, and Wellbeing, Anglia Ruskin University, Cambridge, United Kingdom, **5** Center for Digital Health, Medical Science Research Institute, Kyung Hee University Medical Center, Kyung Hee University College of Medicine, Seoul, Republic of Korea, **6** Department of Pediatrics, Kyung Hee University College of Medicine, Seoul, Republic of Korea, **7** Vision and Eye Research Institute, School of Medicine, Anglia Ruskin University, Cambridge, United Kingdom, **8** Centre for Inclusive Community Eye Health, Anglia Ruskin University, Cambridge, United Kingdom

* masoud.rahmati@univ-amu.fr (MR); shahina.pardhan@aru.ac.uk (SP)

OPEN ACCESS

Citation: Rahmati M, Smith L, Boyer L, Fond G, Yon DK, Lee H, et al. (2025) Vision impairment and associated daily activity limitation: A systematic review and meta-analysis. PLoS ONE 20(1): e0317452. https://doi.org/10.1371/journal.pone.0317452

Editor: Katya Numbers, University of New South Wales, AUSTRALIA

Received: September 2, 2024

Accepted: December 28, 2024

Published: January 31, 2025

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pone.0317452

Data Availability Statement: All relevant data are within the manuscript and its Supporting Information files.

Abstract

Background

Vision impairment is a common disability that poses significant challenges to individuals' ability to perform activities essential for independent living, including activities of daily living (ADL) and instrumental activities of daily living (IADL). Despite extensive research, the extent and nature of these associations remain unclear, particularly across varying levels and types of vision impairment.

Objectives

This meta-analysis aims to estimate associations between vision impairment and difficulties with ADL and IADL.

Methods

We conducted a systematic review of relevant literature from the inception of the databases to February 2024, using electronic database searches, including PubMed, MEDLINE (Ovid), EMBASE, Cochrane CENTRAL, and CDSR. The articles were screened for title and abstract and then for the full-text reports by two independent reviewers and study quality was appraised. Meta-analyses were performed using random effects models to calculate the pooled effect size, expressed as odds ratio (OR) with corresponding 95% confidence interval (CI) of each outcome.

Funding: This study was supported by Vision and Eye Research Institute, School of Medicine, Anglia Ruskin University, Young Street, Cambridge, United Kingdom. The funder had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript; or decision to submit the manuscript for publication.

Competing interests: The authors have declared that no competing interests exist.

Results

Forty-six studies involving 210,960 participants were included. A positive large correlation between vision impairment and difficulties with ADL (Correlation coefficient [*r*] = 0.55, 95% CI 0.37–0.68, *p* = 0.001) and IADL (*r* = 0.60, 95% CI 0.49–0.69, *p* = 0.001) was shown. We also found that vision impairment was associated with difficulties in ADL (OR = 1.77, 95% CI 1.56–2.01, *p* < 0.0001) and IADL (OR = 1.96, 95% CI 1.68–2.30, *p* < 0.0001). Subgroup analysis revealed that moderate to severe impairment resulted in difficulties in ADL (OR = 1.78, 95% CI 1.43–2.21, *p* = 0.02) and IADL (OR = 1.86, 95% CI 1.57–2.20, *p* = 0.0003). Further, there was a significant association between mild to moderate vision impairment and difficulties in IADL (OR = 1.38, 95% CI 1.23–1.55, *p* < 0.0001). Greater impact was observed in individuals with near vision impairment compared to those with distance vision impairment. Near vision impairment was significantly associated with higher difficulties in ADL (OR = 1.77, 95% CI 1.57–2.01, *p* < 0.0001) and IADL (OR = 1.79, 95% CI 1.32–2.42, *p* < 0.0001). In contrast, distance vision impairment showed lower but still significant associations with IADL (OR = 1.19, 95% CI 1.05–1.34, *p* = 0.005) and a nonsignificant association with ADL (OR = 1.12, 95% CI 0.90–1.40, *p* = 0.30). Meta-regression analysis indicated that for every one-year increase in age, ADL performance decreased by an average of 0.0147 units (p < 0.001), while IADL performance declined at a slower rate of 0.0047 units/year (p = 0.031).

Conclusion

The present systematic review and meta-analysis using several statistical methods indicates that vision impairment including near vision impairment, is associated with difficulties in ADL and IADL. Thus, vision impairment remains an urgent and increasingly important public health priority. These findings highlight the need for targeted measures to raise public health awareness to provide rehabilitation and eye care examination strategies to reduce the risk of developing disabilities in adults and the elderly who have vision impairment.

1. Introduction

Vision impairment and blindness are common disabilities affecting more than 338.3 million people worldwide, and that their prevalence increases with advancing age [1, 2]. It has been predicted that the prevalence of vision impairment and blindness will more than double over the next 30 years [1, 2]. Vision impairment is associated with functional disability including activities of daily living, an increased risk of falls, cognitive impairment and dementia, depression, disability, loss of independence, and mortality [1–4]. Near vision impairment or presbyopia is also an important domain in visual disability affecting activities of daily living and there are 1.8 billion people globally with presbyopia [3].

Activities of daily living (ADLs), as an essential component of healthy aging, refer to the fundamental skills necessary for daily self-care. These are further categorized into basic ADL and instrumental ADL (IADL) [5]. ADL encompasses fundamental skills typically needed to manage basic physical needs including feeding, personal hygiene, dressing, ambulating, continence, and toileting. IADL includes more complex activities and organizational skills related to independent living in the community such as housekeeping, managing finances, handling

medications, and meal preparation [5, 6]. The ability to perform ADLs and IADLs without any difficulties is dependent upon cognitive, motor, and perceptual abilities [5] as well as sensory capability. Accordingly, several studies have reported an association between vision impairment and difficulties in ADL and IADL [7–14]. While various individual studies addressed the association between vision impairment and difficulties with ADL and IADL, there is no systematic review and meta-analysis to summarize the pool effects of available evidence. An improved understanding of the association between vision impairment and difficulties in ADL and IADL is needed to inform public policy, public health planning, and allocation of limited healthcare resources. Therefore, we conducted a systematic review and meta-analysis to summarize the current evidence on the association between vision impairment and difficulties with ADL and IADL.

2. Methods

The present systematic review and meta-analysis adhered to the methodological guidelines from the Cochrane Handbook for Systematic Reviews and followed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) statement 2020 in conducting and reporting the review [15]. This systematic review was pre-registered with the International Prospective Register of Systematic Reviews (PROSPERO; ref. no. CRD42023490518). The PRISMA checklist and Meta-analysis of Observational Studies in Epidemiology (MOOSE) checklist [16] are provided, respectively, in S1 and S2 Checklists.

2.1. Search strategy

Two researchers (MR and DKY) electronically searched four databases, including PubMed, MEDLINE (Ovid), EMBASE, Cochrane CENTRAL and CDSR from inception of databases up to February 2024 and disagreements were resolved through discussion with a third reviewer (Sh. P). The search strategy and terms are provided in S1 Table. To find all eligible articles, we searched all reference lists of included studies related to the research question and no language restrictions for studies with English summary were applied in our systematic search.

2.2. Eligibility criteria

The present systematic review and meta-analysis adhered to the inclusion criteria according to the PICO criteria [17]. PICO: Participants include people with vision impairment; Outcome includes those studies reporting difficulties in ADL and IADL; Comparison includes people with normal vision; Intervention is not applicable in the present study. We included both prospective and retrospective cohorts, and cross-sectional studies that evaluated the risk of developing disability in ADL and IADL in participants with vision impairment (S2 Table). We excluded studies lacking data to calculate odds ratio or association between vision impairment with disability in ADL or IADL. Studies were excluded if their primary research question was not exploring the association between vision impairment with disability in ADL or IADL. Additionally, studies were excluded if they were narrative literature reviews (although their reference lists were explored for potentially eligible studies; S3 Table).

2.3. Data extraction and quality assessment

We extracted data using Covidence systematic review software (version 2, Veritas Health Innovation, Melbourne, VIC, Australia) on a pre-designed spreadsheet, following Cochrane guidelines. The following data were extracted from the eligible studies: author and year, study design, country, age of participants, sample size, the proportion of female participants, ADL

and IADL measurements, vision assessment criteria, vision impairment characteristics, and adjusted variables. The primary outcome was the association between vision impairment with disability in ADL. The secondary outcome was the association between vision impairment with disability in IADL. The quality of included prospective studies were assessed using the Newcastle–Ottawa Scale (NOS) [15, 18, 19]. Data extraction and quality assessment were independently performed by two reviewers (MR and DKY), and disagreements were resolved through discussion with a third reviewer (Sh. P) before conducting meta-analysis.

2.4. Statistical analyses

Outcomes were pooled and expressed as odds ratio (OR) with corresponding 95% confidence intervals (CI) based on one-stage approach and the random-effects estimate using the DerSimonian-Laird method [20, 21]. When data extraction for re-estimation of the association between vision impairment and ADL or IADL was not possible, study reported estimates (log- odds ratio) and variances were combined directly using generic inverse variance meta-analysis [20, 22, 23]. To evaluate the potential impact of age on the relationship between vision impairment and ADL or IADL, a random-effects meta-regression analysis was conducted. The dependent variable was the Fisher z-transformed correlation coefficient, and age was used as the moderator (independent variable) in the analysis, employing the restricted maximum likelihood (REML) approach. Meta-analyses of correlations across observational studies were carried out where the relationship between vision impairment with ADL and IADL scores were measured using the same constructs. A Fisher *z* transformation of the correlation coefficient was carried out, and random-effects meta-analysis of the transformed values was conducted. Pearson *r* values of 0.1, 0.3, and 0.5 were considered to show small, moderate, and large effects, respectively, and are presented with 95% CIs [24]. MedCalc software version 20.104 (MedCalc software Ltd, Acacialaan 22 8400 Ostend-Belgium) was used to perform meta-analysis of correlational data [25]. The degree of between-study heterogeneity that could not be ascribed to sampling error was explored using Cochran's Q statistics and I-squared (I^2; low: 0–40%%, moderate: 30–60%, substantial: 50–90%, and considerable: $>$ 75%) to estimate heterogeneity. Further, the potential for publication bias was assessed using funnel plots with *Egger's* linear regression and *Begg's* rank tests, when the sufficient number of studies (n $>$ 10) was available [21, 26]. Finally, to assess the robustness of summary estimates and to detect if any particular study accounted for a large proportion of heterogeneity, sensitivity analysis was performed by the leave-one-out method [6, 27]. All meta-analyses in the current study were conducted using Review Manager (version 5.4; The Nordic Cochrane Centre, Copenhagen, Denmark), MedCalc software version 20.104 (MedCalc software Ltd, Acacialaan 22 8400 Ostend-Belgium), and Comprehensive Meta-analysis (version 3.3; Biostat Inc., Englewood, NK), a two-sided P value less than 0.05 was considered statistically significant.

2.5. Subgroup analysis

We performed four sets of subgroup analyses by 1) different vision impairment assessment (self-reported versus objectively measured), 2) severity of vision impairment ((mild to moderate [visual acuity between 20/200-20/70 in the better seeing eye]) versus moderate to severe (visual acuity between 20/70 to 20/160 and worse than 20/200 in the better seeing eye)), 3) different ADL or IADL assessment (self-reported versus objectively measured by a trained neuropsychologist or a registered nurse), and 4) different vision impairment characteristics (distance vision versus near vision and both distance and near vision).

3. Results

3.1. Study identification and characteristics

A total of 3304 titles were identified through database searches. 1837 studies remained after removing duplicates. After screening titles and abstracts, 1756 research articles were excluded. Of 81 obtained research articles, another 35 articles were excluded (other outcomes considered (n = 31), case study (n = 2), and reviews (n = 2)). Finally, 46 articles met the eligibility criteria and were included in the meta-analysis (Fig 1). Included studies were published between 1994 to 2022. A total of 210,960 participants were included in this analysis. The age of the participants ranged from 18 to 105 years.

Included studies used the following assessment criteria and charts to detect vision impairment: Self-reported data (N = 17) [7, 8, 12, 14, 28–40], ophthalmologists examination (N = 9) [9, 41–48], Snellen E Chart (N = 3) [10, 49, 50], Bailey–Lovie chart (N = 3) [51–53], Monoyer chart [54], Lighthouse near VA chart (N = 2) [11, 55], Pelli-Robson CS chart (N = 3) [11, 48, 51], Parinaud scale [56], Berkeley glare test [57], Early Treatment Diabetic Retinopathy Study charts (ETDRS) (N = 3) [13, 46, 47], Visual acuity criterion of legal blindness in the

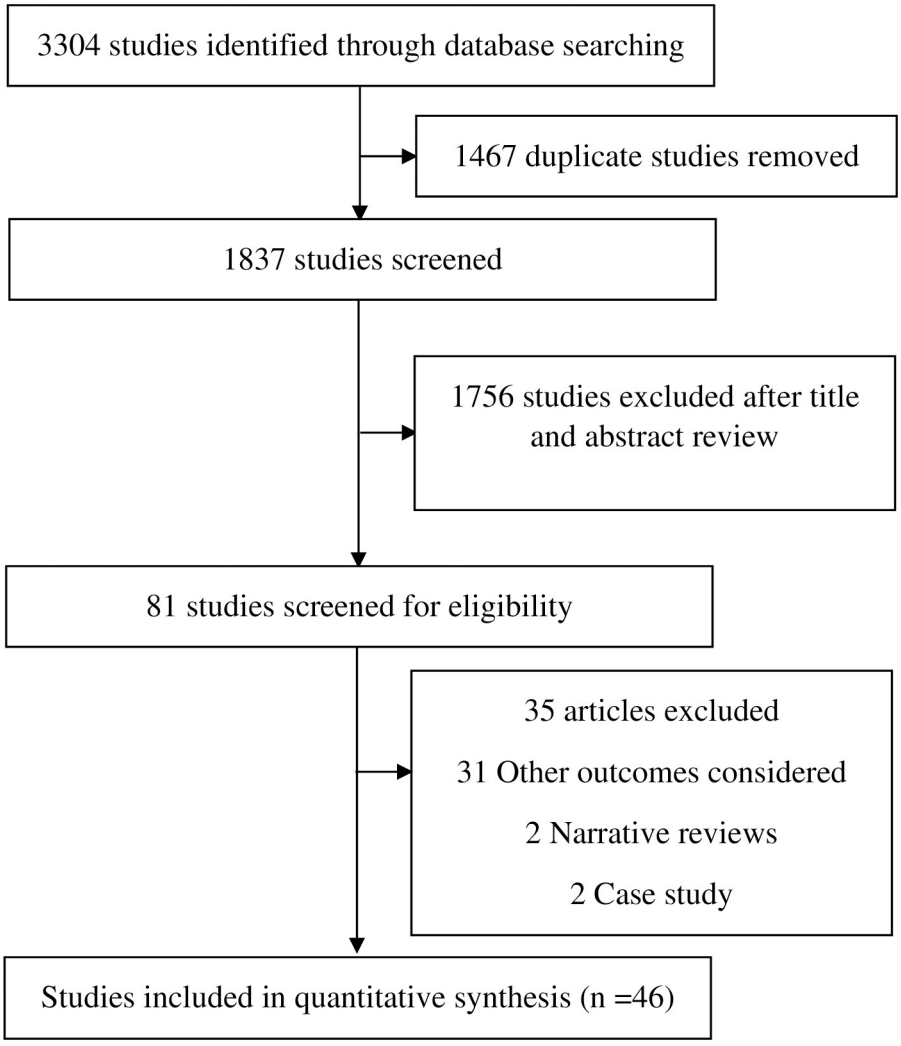


Fig 1. PRISMA flow diagram of study selection.

https://doi.org/10.1371/journal.pone.0317452.g001

United States [58], Visual Analogue Scale [14], Vistech VCTS 6500 charts [52], Physician diagnosis [59], ability to see a break in a circle on a cardboard sheet 1m away [60], Randot Circles chart [53], International Classification of Functioning, Disability and Health [61], N-30–5 algorithm of FDT perimetry [62], Humphrey 81-point full-field screen [48], and RANDOT circles test [48]. Vision impairment characteristics were not reported in 23 studies [7–9, 12, 14, 28–31, 33–40, 52, 53, 57, 61–63]. Although, visual acuity worse than 0.3 logarithm of the minimum angle of resolution (logMAR) (N = 10) [10, 41, 43–46, 48–50, 56] and worse than 0.5 logMAR (N = 7) [13, 42, 46, 49, 55, 58, 64] in the better-seeing eye were reported in some studies. Additionally, vision impairment characteristics in four studies were reported based on common eye disorders and diseases [47, 51, 54, 59].

Katz ADL was used in 20 studies [10, 31, 32, 34, 35, 37–40, 43, 44, 47, 48, 50, 53–55, 57, 60, 62] and Barthle index was used in three studies [8, 9, 14] respectively to assess difficulties with ADL. Lawton instrumental activities of daily living was used in 25 studies to assess difficulties with IADL [10–12, 31–35, 37–40, 43–45, 47–50, 53–55, 57, 60, 62]. All other studies had developed an adapted questionnaire to assess the motor component of ADL and IADL. Activity limitation in ADL or IADL were actively screened by a trained neuropsychologist or a registered nurse during an at-home visit in six studies [43, 44, 52, 54–56].

All excluded studies are listed in S3 Table. Included studies were of cohort (N = 21) [13, 14, 28–34, 37–40, 42, 44, 48, 49, 56, 58, 60, 61] and cross-sectional design (N = 25) [7–12, 35, 36, 41, 43, 45–47, 50–57, 59, 62–64] and were of medium to high quality, with NOS scores between 5 and 9 (S4 Table). Quantitative analysis of publication bias with Egger's test and Begg's test was non-significant for all analyses (S1 Fig). The general characteristics of included studies are provided in Table 1.

Table 1. General characteristics of included studies.

Study	Design	Country	Age (year)	Participant (Female%)	ADL measurement	IADL measurement	Vision assessment	Vision impairment characteristics	Adjusted variables
Bekibele et al. 2008 [32]	Cohort	Nigeria	>65	2054 (53)	Katz Activities of Daily Living	Nagi Physical Performance Scale and the Health Assessment Questionnair	Self-reported vision impairment	Distance vision Near vision	Socio-demographic Health-related
Berger et al. 2008 [7]	Cross-sectional	US	>65	9115 (NR)	Difficulty with getting across a room, dressing, bathing, eating, getting out of bed, or using the toilet	Difficulty with preparing a hot meal; shopping for groceries; making phone calls; taking medications; and managing money	Self-reported vision impairment	NR	Socio-demographic Health-related
Bouscaren et al. 2019 [33]	Cohort	France	>75	4010 (100)	NR	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
Brennan et al. 2005 [34]	Cohort	US	>70	5151 (NR)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
Cacciatore et al. 2004 [35]	Cross-sectional	Italy	>65	1780 (57)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related

(*Continued*)

Table 1. (Continued)

Study	Design	Country	Age (year)	Participant (Female%)	ADL measurement	IADL measurement	Vision assessment	Vision impairment characteristics	Adjusted variables
Cao et al. 2021 [60]	Cohort	China	>65	16151 (51)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Ability to see a break in a circle on a cardboard sheet 1m away	NR	Socio-demographic Health-related
Chan et al. 2021 [8]	Cross-sectional	Malaysia	>60	3977 (53)	Barthel index	NR	Washington Group Extended Questions Set on Functioning	NR	Socio-demographic Health-related Social-related
Cimarolli et al. 2014 [36]	Cross-sectional	US	>95	119 (78)	Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire	Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire	Self-reported vision impairment	NR	Socio-demographic Health-related
Crews et al. 2004 [28]	Cohort	National Center for Health Statistics	>70	6379 (65)	Difficulty with getting across a room, dressing, bathing, eating, getting out of bed, or using the toilet	Difficulty with preparing a hot meal; shopping for groceries; making phone calls; taking medications; and managing money	Self-reported vision impairment	NR	Socio-demographic Health-related
Daien et al. 2014 [41]	Cross-sectional	France	>65	1887 (55)	NR	Lawton instrumental activities of daily living	Ophthalmologists	Mild: 0.3–0.5 (20/40–20/70) Moderate to severe: worse than 0.5 <20/70	Socio-demographic Health-related
Dargent-Molinaet al. 1996 [49]	Cohort	France	>75	1210 (100)	NR	Lawton instrumental activities of daily living	Snellen E Chart	Corrected acuity 5-7/10 3-4/10 ≥ 2/10	Socio-demographic Health-related
Dijkhuizen et al. 2016 [9]	Cross-sectional	Netherland	19–86	240 (37)	Barthel index Comfortable Walking Speed	NR	Ophthalmologists	NR	Socio-demographic Health-related
Ensrud et al. 1994 [53]	Cross-sectional	US	>65	9704 (100)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Bailey–Lovie chart Randot Circles chart Vistech Contrast Sensitivity Test System	NR	Socio-demographic Health-related
Falahaty et al. 2015 [10]	Cross-sectional	Malaysia	>60	150 (54)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Snellen E Chart	Corrected acuity 6/18-6/36	Socio-demographic Health-related
Grue et al. 2009 [29]	Cohort	Denmark	>75	770 (65)	Difficulty with getting across a room, dressing, bathing, eating, getting out of bed, or using the toilet	Difficulty with preparing a hot meal; shopping for groceries; making phone calls; taking medications; and managing money	Unable to read regular print in a newspaper	NR	Socio-demographic Health-related

(*Continued*)

Table 1. (Continued)

Study	Design	Country	Age (year)	Participant (Female%)	ADL measurement	IADL measurement	Vision assessment	Vision impairment characteristics	Adjusted variables
Guo et al. 2021 [46]	Cross-sectional	US	>70	1053 (63)	Difficulty with walking from one room to another on the same level, getting in or out of bed, eating or drinking, and dressing oneself	Difficulty with doing chores around the house, preparing one's own meal, and managing one's money	Ophthalmologists Early Treatment Diabetic Retinopathy Study chart	Mild (20/40–20/60) Moderate or greater (<20–60)	Socio-demographic Health-related
Guthrie et al. 2018 [63]	Cross-sectional	Canada	>65	11829 (71)	Difficulty with getting across a room, dressing, bathing, eating, getting out of bed, or using the toilet	Difficulty with preparing a hot meal; shopping for groceries; making phone calls; taking medications; and managing money	Resident Assessment Instrument for Home Care and the Minimum Data Set 2.0	NR	Socio-demographic Health-related
Harada et al. 2008 [64]	Cross-sectional	Japan	>65	843 (58)	NR	Tokyo Metropolitan Institute of Gerontology Index of Competence	Trained technicians	Corrected acuity of worse than 0.5	Socio-demographic Health-related
Haymes et al. 2002 [51]	Cross-sectional	Australia	20–89	120 (62)	Melbourne Low Vision ADL Index	Melbourne Low Vision IADL Index	Bailey–Lovie chart Pelli–Robson Chart	Retinitis pigmentosa (12.5%), Macular dystrophy (7.5%), Optic atrophy (5%), Diabetic retinopathy (3%), Glaucoma (2.5%), Myopic degeneration (2.5%), Retinal vein occlusion (1.5%), cataract (1.5%)	NR
Hochberget al. 2012 [47]	Cross-sectional	US	60–80	191 (58)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Ophthalmologists Early Treatment Diabetic Retinopathy Study chart	Glaucoma Age-related macular degeneration	Socio-demographic Health-related
Horowitz et al. 1994 [42]	Cohort	US	44–99	114 (NR)	Monthly Nurse's Assessment	NR	Optometric Examination Record	Moderate: Corrected acuity 20/70-20/100 Severe: Corrected acuity ≥20/200	Socio-demographic Health-related
Ivanoff et al. 2000 [54]	Cross-sectional	Sweden	85	617 (35)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Monoyer chart	Cataract (54%), Cataract and other eye diseases (29%), Other eye diseases (17%)	NR
Kee et al. 2021 [11]	Cross-sectional	Malaysia	>60	208 (57)	NR	Lawton instrumental activities of daily living	Lighthouse near VA chart and Pelli-Robson CS chart	Near visual impairment	NR
Keller et al. 1999 [55]	Cross-sectional	US	>60	576 (72)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Lighthouse near VA chart	Corrected acuity ≥20/70	Socio-demographic Health-related

(*Continued*)

Table 1. (Continued)

Study	Design	Country	Age (year)	Participant (Female%)	ADL measurement	IADL measurement	Vision assessment	Vision impairment characteristics	Adjusted variables
Laitinen et al. 2007 [50]	Cross-sectional	Finland	>55	2870 (60)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Snellen E Chart	Impaired: ≤0.25 (≤20/80) Reduced: 0.5–0.63 (20/40–20/32) Moderate: 0.32–0.4 (20/63–20/50)	Socio-demographic Health-related
Lam et al. 2013 [65]	Cohort	US	65–84	2520 (58)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Early Treatment Diabetic Retinopathy Study chart	NR	Socio-demographic Health-related
Liu et al. 2016 [37]	Cohort	US	>65	3871 (65)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
Mercan et al. 2021 [12]	Cross-sectional	Turkey	>65	578 (53)	NR	Lawton instrumental activities of daily living	International Classification of Functioning, Disability and Health	NR	Socio-demographic Health-related
Mueller-Schotte et al. 2019 [61]	Cohort	Netherland	>60	9319 (59)	NR	Modified KATZ-15 IADL questionnaire	International Classification of Functioning, Disability and Health	NR	Socio-demographic Health-related
Naël et al. 2017 [43]	Cross-sectional	France	>65	709 (65)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Ophthalmologists	> 20/32–20/25 > 20/40–20/32 > 20/63–20/40 ≤ 20/63	Socio-demographic Health-related
Park et al. 2015 [59]	Cross-sectional	South Korea	>55	9047 (55)	Difficulty with dressing, washing face, bathing, feeding, transferring, using toilet, and incontinence	NR	Physician diagnosis	Glaucoma	Socio-demographic Health-related
Pér'es et al. 2017 [56]	Cohort Cross-sectional	France	>65	9294 (60)	Difficulty with bathing; dressing; eating; standing up from bed/chair or sitting down on a chair; walking indoors; and toileting	Difficulty with preparing own meals; shopping; managing money; using the telephone; doing housework; taking transportation; and taking prescribed medication	Parinaud scale	Corrected acuity < 20/30	Socio-demographic Health-related
Qiu et al. 2014 [62]	Cross-sectional	US	>40	5186 (NR)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	N-30–5 algorithm of FDT perimetry	NR	Socio-demographic Health-related
Reuben et al. 1999 [44]	Cohort	US	>60	5646 (53)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Ophthalmologists	Corrected acuity ≥20/40	Socio-demographic Health-related
Rokicki et al. 2016 [45]	Cross-sectional	Poland	>55	623 (100)	NR	Lawton instrumental activities of daily living	Ophthalmic examination	Corrected acuity ≤ 0.7–0.3	NR

(*Continued*)

Table 1. (Continued)

Study	Design	Country	Age (year)	Participant (Female%)	ADL measurement	IADL measurement	Vision assessment	Vision impairment characteristics	Adjusted variables
Ross et al. 1991 [52]	Cross-sectional	US	33–94	144 (4)	NR	Identifying currency, reading a wristwatch, playing cards, using a ruler, dialing a telephone	Bailey-Lovie chart, Vistech VCTS 6500 charts	NR	NR
Rovner et al. 1998 [30]	Cohort	US	>68	872 (60)	NR	Older Americans Research and Service Center Instrument	Self-reported vision impairment	NR	Socio-demographic
Rubin et al. 1994 [57]	Cross-sectional	US	>65	222 (64)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Berkeley glare test, Randot circles test	NR	Socio-demographic Health-related
Swanson et al. 2004 [38]	Cohort	US	>18	67570 (54)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
Tareque et al. 2019 [31]	Cohort	Singapore	>60	3452 (54)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Health-related
Verbeek et al. 2022 [13]	Cohort	Netherland	>85	548 (66)	Groningen Activity Restriction Scale	Groningen Activity Restriction Scale	Early Treatment Diabetic Retinopathy Study charts	Moderate (0.5≤ visual acuity ≤0.7) Severe visual impairment (visual acuity <0.5).	NR
Wahl et al. 1999 [58]	Cohort	Germany	>65	67 (71)	Schneekloth and Potthoff items	Schneekloth and Potthoff items	Visual acuity criterion of legal blindness in the United States	Visual acuity between 20/200 and 20/600	Socio-demographic Health-related
Wallhagen et al. 2001 [39]	Cohort	US	>50	2442 (57)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
West et al. 1997 [48]	Cohort	US	65–84	4624 (59)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Ophthalmologists ETDRS charts Pelli Robson chart Humphrey 81-point full-field screen RANDOT circles test	Visual acuity worse than 20/40	Socio-demographic Health-related
Whitson et al. 2007 [40]	Cohort	US	>65	3878 (64)	Katz Activities of Daily Living	Lawton instrumental activities of daily living	Self-reported vision impairment	NR	Socio-demographic Health-related
Zhang et al. 2022 [14]	Cohort	China	>80	1750 (72)	Barthel index	NR	Visual Analogue Scale	NR	Socio-demographic Health-related

NR, Not reported.

https://doi.org/10.1371/journal.pone.0317452.t001

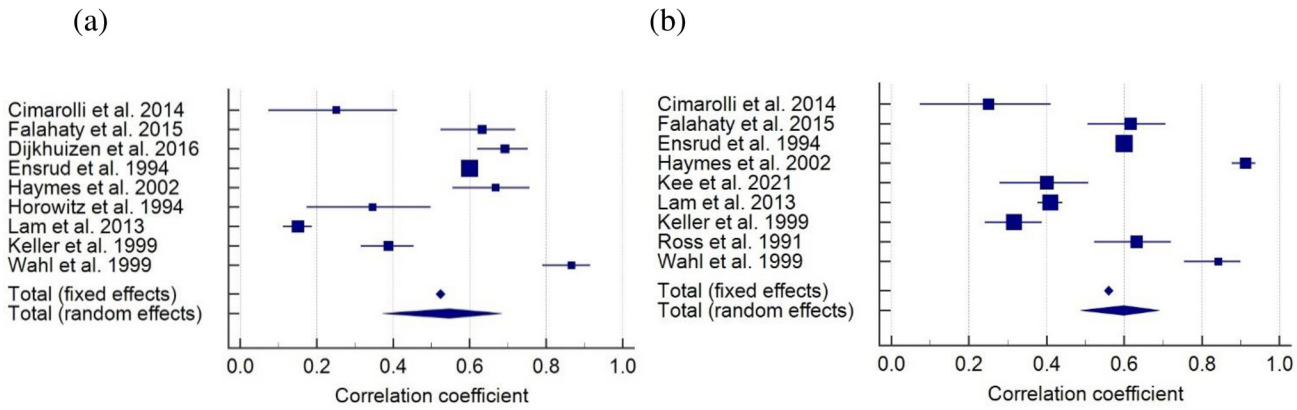


Fig 2. Forest plot of correlation between vision impairment and difficulties with (a) ADL and (b) IADL.

https://doi.org/10.1371/journal.pone.0317452.g002

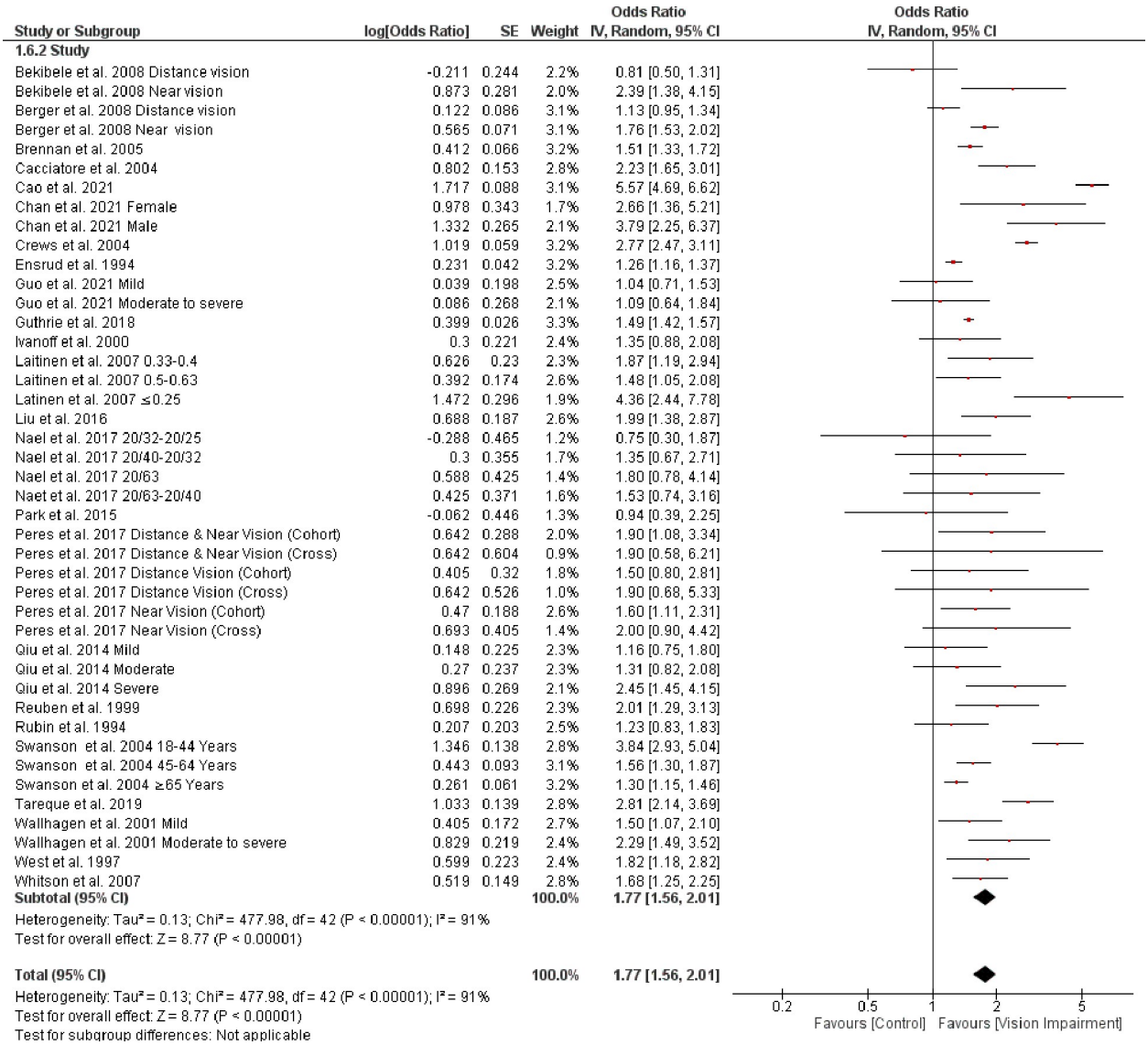
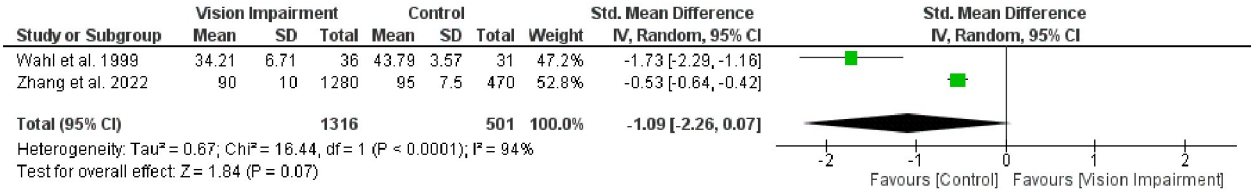


Fig 3. Forest plot of the association between vision impairment and difficulties with activity of daily living.

https://doi.org/10.1371/journal.pone.0317452.g003

(a)



(b)

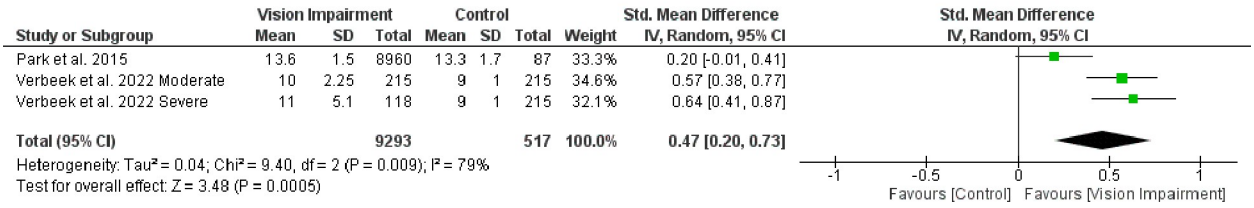


Fig 4. Forest plot of the association between vision impairment and difficulties with activity of daily living using two different pooled SMD analysis.

https://doi.org/10.1371/journal.pone.0317452.g004

3.2. Correlation between vision impairment and difficulties with activity of daily living

Eight studies [9, 10, 36, 42, 51, 53, 55, 58, 65] involving 10,700 participants reported a correlation between vision impairment and difficulties with ADL. The pooled correlation coefficient was 0.55 (95% CI 0.37–0.68, $p = 0.001$), indicating a positive large correlation between vision impairment and difficulties with ADL (Fig 2A). The values of $I^2 = 99\%$ ($p < 0.0001$) indicated that significant heterogeneity exists in the included studies. Additionally, nine studies [10, 11, 36, 51–53, 55, 58, 65] involving 11,088 participants reported a correlation between vision impairment and difficulties with IADL. The pooled correlation coefficient showed a positive large correlation between vision impairment and difficulties with IADL ($r = 0.60$, 95% CI 0.49–0.69, $p = 0.001$) (Fig 2B). There was evidence of significant heterogeneity across included studies ($I^2 = 97\%$, $p < 0.0001$).

3.3. Association of vision impairment and difficulties with activities of daily living

Twenty-three studies [7, 8, 28, 31, 32, 34, 35, 37–39, 43, 44, 46, 48, 50, 53, 54, 56, 57, 59, 60, 62, 63] involving 182,743 participants reported association between vision impairment and difficulties with ADL. The random-effect model by pooling log- odds ratio using generic inverse variance meta-analysis showed that vision impairment was significantly associated with difficulties in activity of daily living (OR = 1.77, 95% CI 1.56–2.01, $p < 0.0001$) (Fig 3). The values of $I^2 = 91\%$ ($p < 0.0001$) indicated that significant heterogeneity exists in the included studies. Additionally, the pooled SMD analyses from Wahl et al. 1999 [58] and Zhang et al. 2022 [14] studies indicated a trend toward association between vision impairment and difficulties with ADL (SMD = -1.09, 95% CI -2.26–0.07, $p = 0.07$) (Fig 4A). Moreover, using a different assessment criterion from Park et al. 2015 [59] and Verbeek et al. 2022 [13] studies indicated significant association between vision impairment and difficulties with ADL (SMD = 0.47, 95% CI 0.20–0.73, $p = 0.0005$) (Fig 4B).

Stratifying studies by different assessment of vision impairment showed non-significant higher difficulties in studies that used self-reported assessment (OR = 1.80, 95% CI 1.55–2.09,

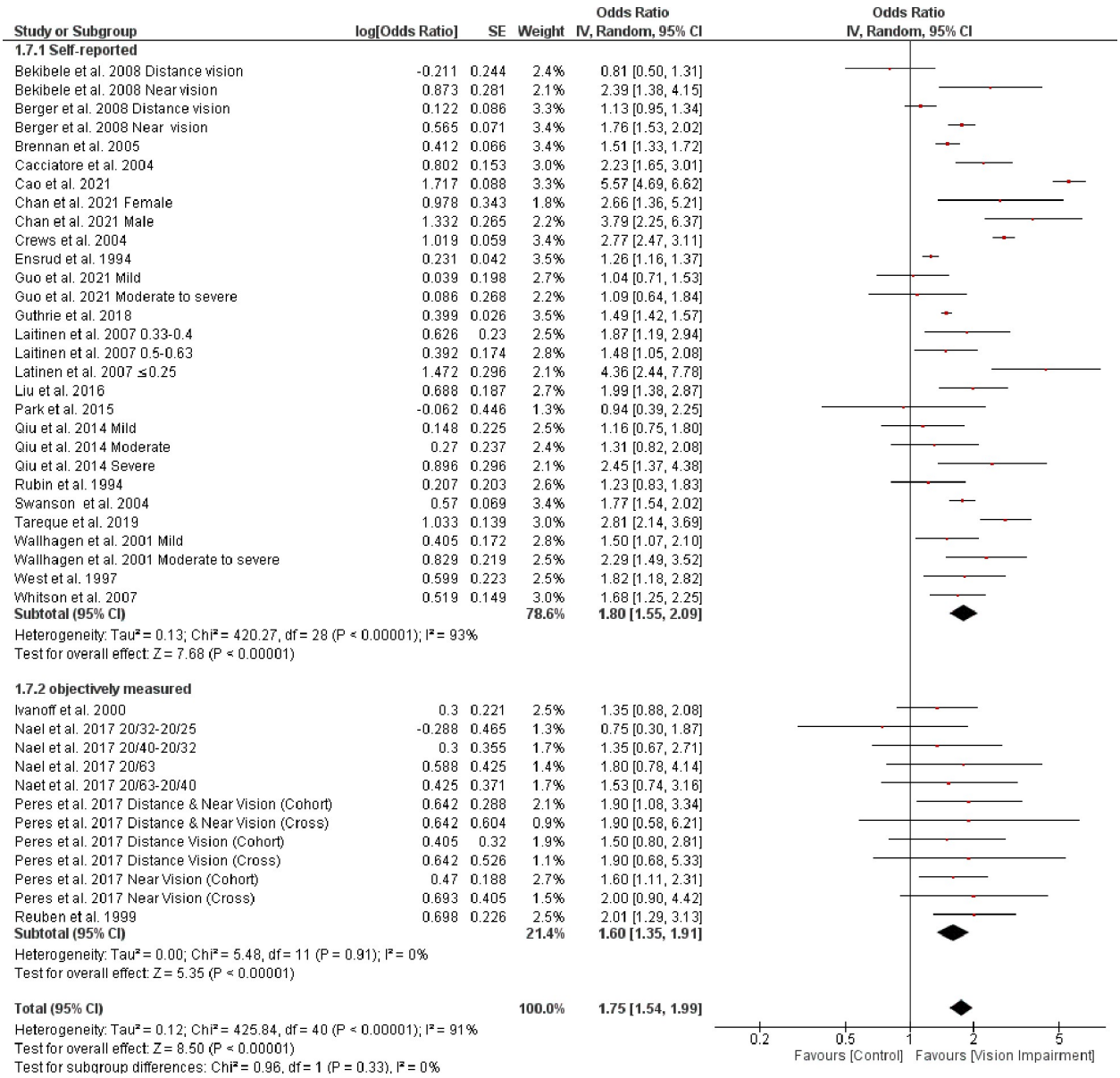


Fig 5. Forest plot of the association between vision impairment and difficulties with activity of daily living based on different ADL assessments.

https://doi.org/10.1371/journal.pone.0317452.g005

$p < 0.0001$, $I^2 = 93\%$, $p < 0.0001$) compared with studies that objectively assessed vision impairment (OR = 1.60, 95% CI 1.35–1.91, $p < 0.0001$, $I^2 = 0\%$, $p = 0.91$) (test for subgroup difference: $Chi^2 = 0.96$, $p = 0.33$) (Fig 5). However, the result of sensitivity analysis indicated that after removing Cao et al. 2021 [60], the heterogeneity dropped to 46% (Fig 6).

Subgroup analysis based on severity of vision impairment revealed higher ADL difficulties with moderate to severe impairment (visual acuity between 20/70 to 20/160 and worse than 20/200 in the better seeing eye) (OR = 1.78, 95% CI 1.43–2.21, $p = 0.00001$, $I^2 = 44\%$, $p = 0.02$) compared with mild to moderate impairment (visual acuity ≤ 20/200-20/70 in the better seeing eye) (OR = 1.28, 95% CI 1.06–2.54, $p = 0.5$, $I^2 = 38\%$, $p = 0.01$) (test for subgroup difference: $Chi^2 = 4.95$, $p = 0.03$) (Fig 7).

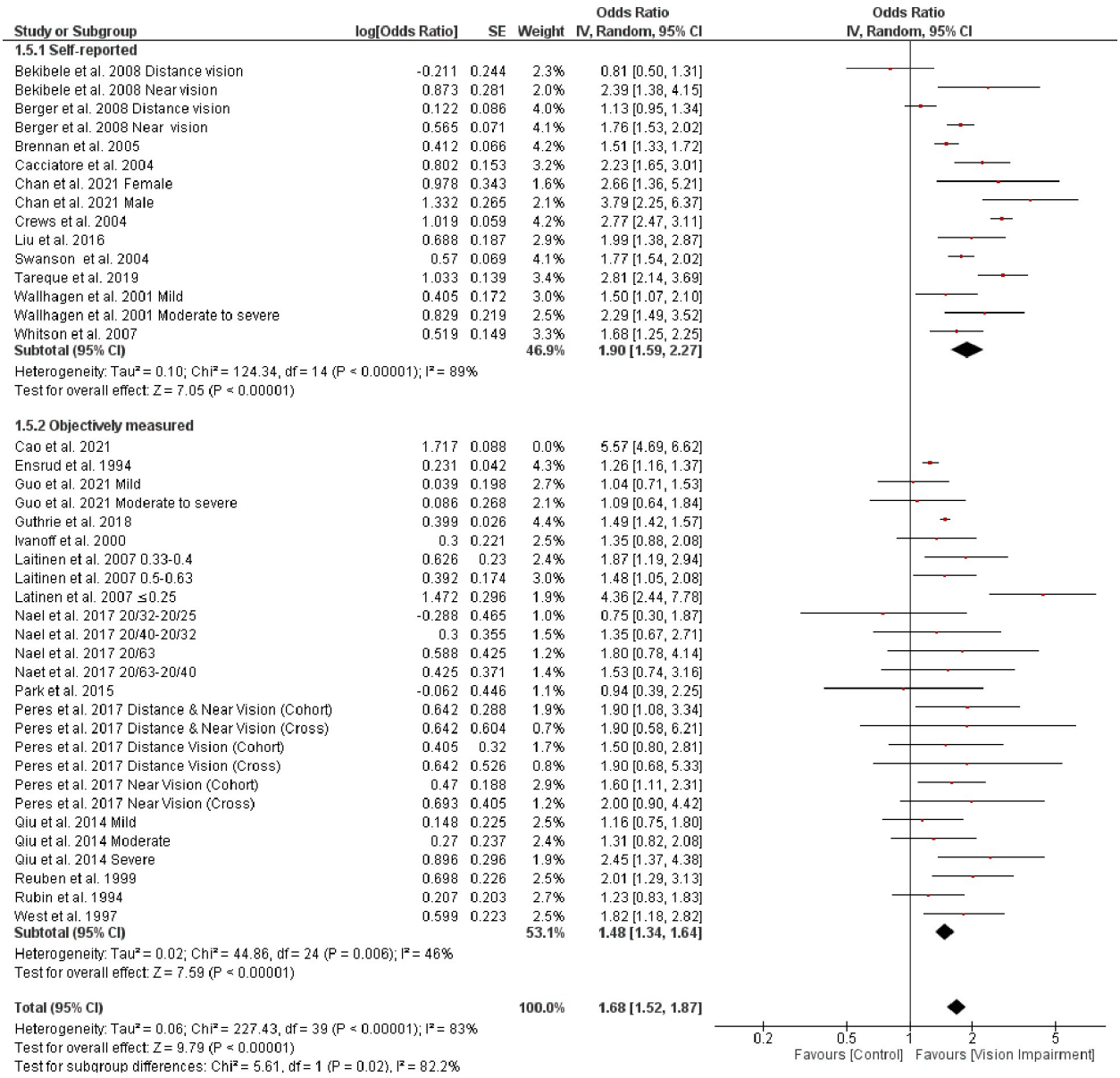


Fig 6. Sensitivity analysis for the association between vision impairment and difficulties with activity of daily living based on different ADL assessments.

https://doi.org/10.1371/journal.pone.0317452.g006

Further, subgroup analysis based on different assessment of ADL showed a non-significant higher difficulty in studies that used self-reported assessment (OR = 1.80, 95% CI 1.55–2.09, $p < 0.0001$, $I^2 = 93\%$, $p < 0.0001$) compared with studies that objectively assessed ADL (OR = 1.60, 95% CI 1.35–1.91, $p < 0.0001$, $I^2 = 0\%$, $p = 0.91$) (test for subgroup difference: $Chi^2 = 0.96$, $p = 0.33$) (Fig 8). Although, the heterogeneity dropped to zero in studies that objectively assessed ADL, implicating that the source of heterogeneity is related to the assessment method of ADL.

Finally, subgroup analysis based on different vision impairment characteristics showed significant higher difficulty in ADL in people with distance vision impairment (OR = 1.12, 95% CI 0.90–1.40, $p = 0.30$, $I^2 = 17\%$, $p = 0.31$) and also in people with both distance and near vision

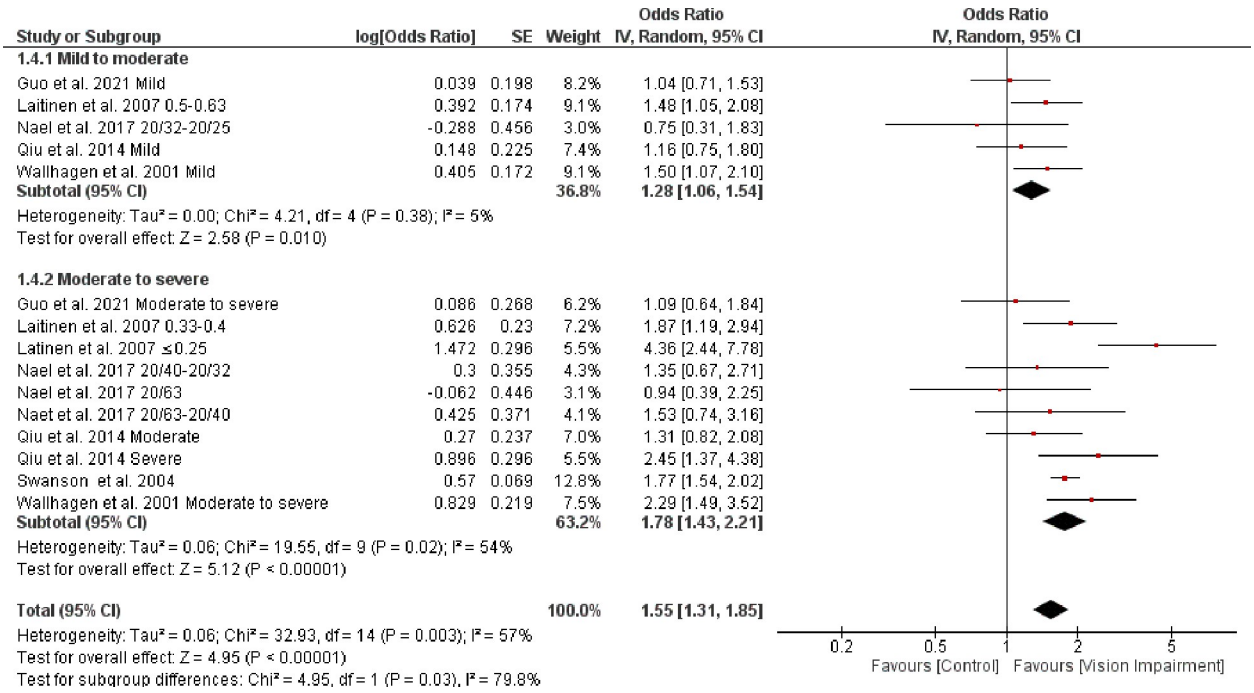


Fig 7. Forest plot of the association between vision impairment and difficulties with activity of daily living based on severity of vision impairment.

https://doi.org/10.1371/journal.pone.0317452.g007

impairments (OR = 1.90, 95% CI 1.14–3.16, $p = 0.01$, $I^2 = 0\%$, $p = 1.00$) compared with people with near vision impairment (OR = 1.77, 95% CI 1.57–2.01, $p < 0.0001$, $I^2 = 0\%$, $p = 0.67$) (test for subgroup difference: $Chi^2 = 12.83$, $p = 0.002$) (Fig 9). Importantly, heterogeneity dropped to zero and 17% for these three analyses showing that vision impairment characteristics was another source of heterogeneity.

3.4. Association of vision impairment and difficulties with Instrumental activities of daily living (IADL)

Thirty-two studies [7, 11, 12, 28–35, 37–41, 43, 44, 46–50, 53, 54, 56, 57, 60–64] involving 193,485 participants reported associations between vision impairment and difficulties with IADL. Overall pooled analyses showed that there is a significant association between vision impairment and difficulties with IADL (OR = 1.96, 95% CI 1.68–2.30, $p < 0.0001$, $I^2 = 96\%$, $p < 0.0001$) (Fig 10).

Subgroup analysis based on the different assessment of vision impairment showed higher odds of IADL in studies that used self-reported assessment (OR = 2.19, 95% CI 1.85–2.61, $p = 0.00001$, $I^2 = 89\%$, $p < 0.0001$) compared with studies that objectively assessed vision impairment (OR = 1.83, 95% CI 1.46–2.28, $p < 0.0001$, $I^2 = 97\%$, $p < 0.0001$). However, the test for subgroup difference was not statistically significant ($Chi^2 = 1.65$, $p = 0.20$) (Fig 11). Further, subgroup analysis based on severity of vision impairment revealed a higher significant difficulty in IADL in participants with moderate to severe vision impairment (visual acuity between 20/70 to 20/160 and worse than 20/200 in the better seeing eye)) (OR = 1.86, 95% CI 1.57–2.20, $p = 0.00001$, $I^2 = 56\%$, $p = 0.007$) compared with participants with mild to moderate vision impairment (visual acuity $\leq$ 20/200-20/70 in the better seeing eye)) (OR = 1.38, 95% CI 1.23–1.55, $p < 0.0001$, $I^2 = 0\%$, $p = 0.50$) (test for subgroup difference: $Chi^2 = 8.21$, $p = 0.004$)

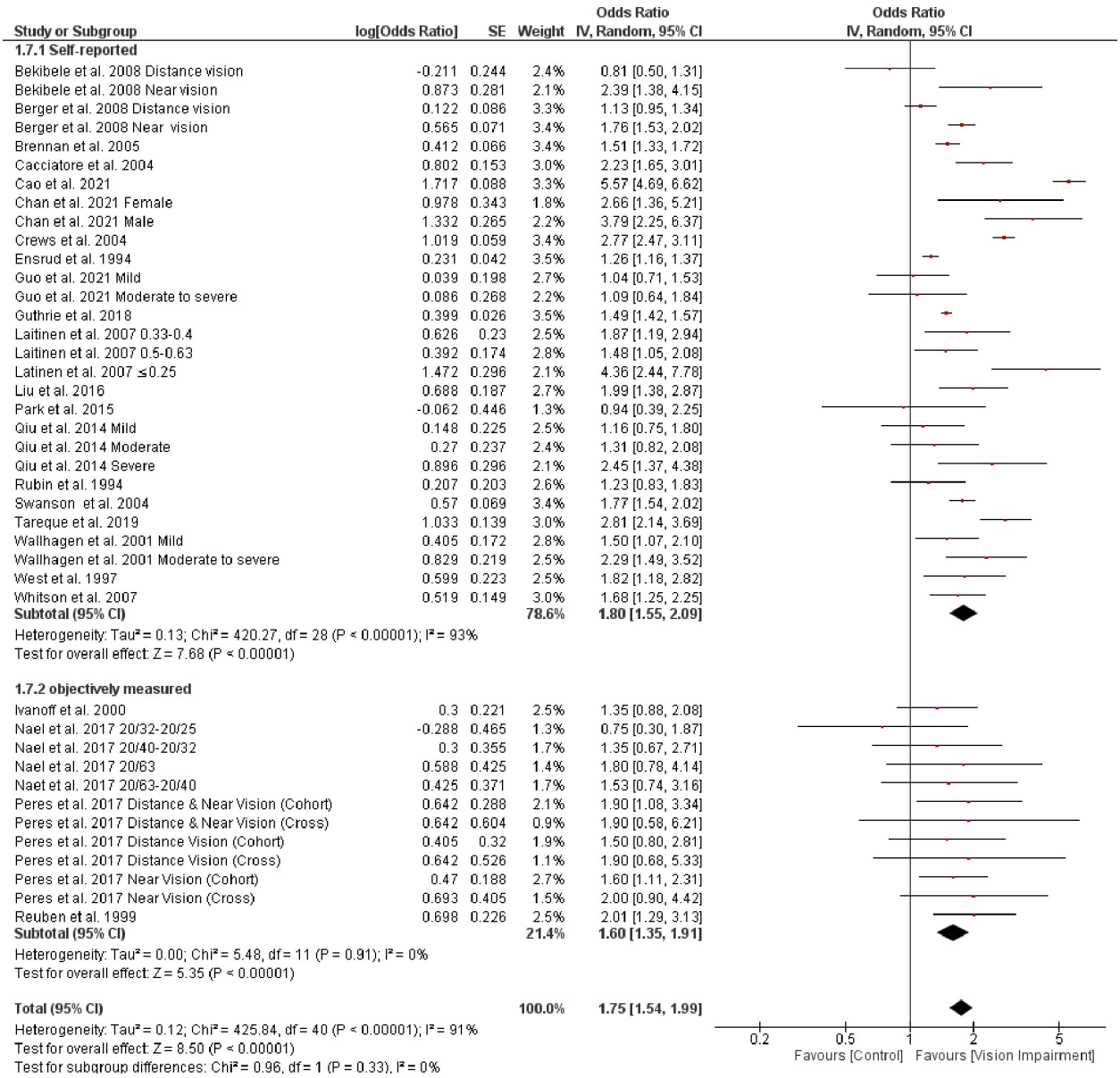


Fig 8. Forest plot of the association between vision impairment and difficulties with activity of daily living based on different assessments of ADL.

https://doi.org/10.1371/journal.pone.0317452.g008

(Fig 12). Further, subgroup analysis based on the different assessments of IADL showed a significant trend toward higher difficulty in IADL in studies that used self-reported assessment (OR = 2.07, 95% CI 1.72–2.49, $p < 0.0001$, $I^2 = 97\%$, $p < 0.0001$) compared with studies that objectively assessed IADL (OR = 1.60, 95% CI 1.28–2.00, $p < 0.0001$, $I^2 = 81\%$, $p < 0.0001$) (test for subgroup difference: $Chi^2 = 3.05$, $p = 0.08$) (Fig 13). The result of sensitivity analysis revealed that after removing data for distance and near vision impairment from the cross-sectional study Peres et al. 2017 [56], the heterogeneity dropped to zero, implicating that the source of heterogeneity is related to the assessment method of IADL (Fig 14). Finally, subgroup analysis based on different vision impairment characteristics showed significant higher difficulty in ADL in people with near vision impairment (OR = 1.79, 95% CI 1.32–2.42,

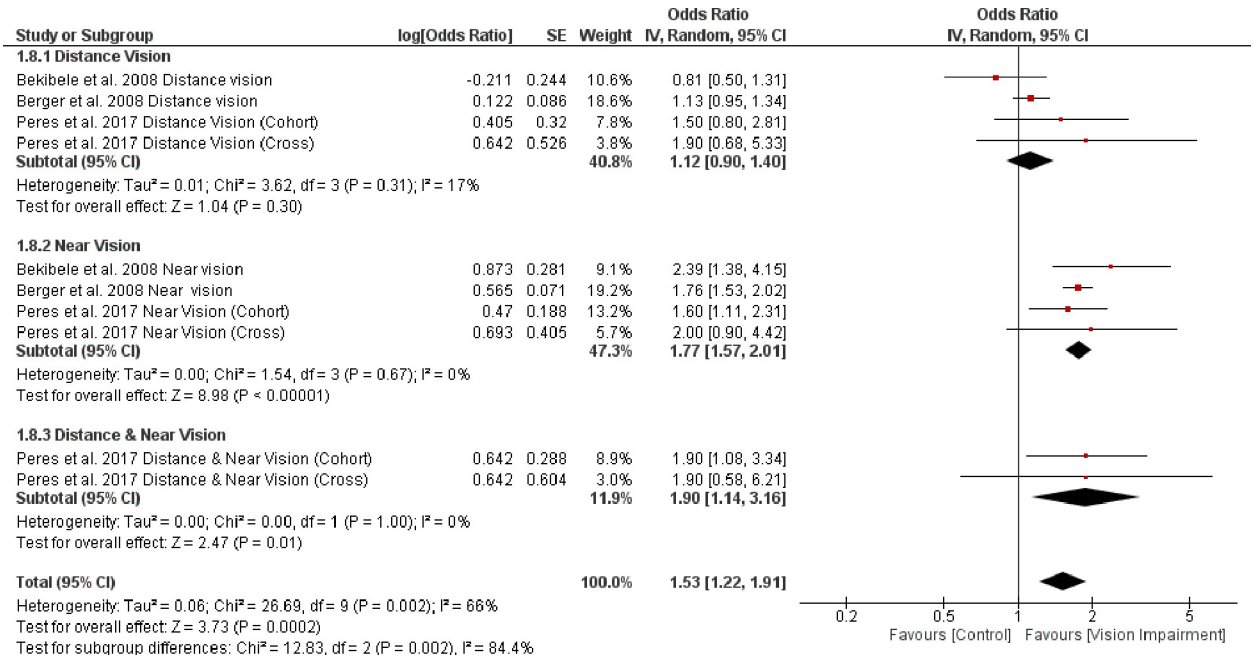


Fig 9. Forest plot of the association between vision impairment and difficulties with activity of daily living based on different vision impairment characteristics.

https://doi.org/10.1371/journal.pone.0317452.g009

$p = 0.0002$, $I^2 = 87\%$, $p < 0.0001$) compared with people with distance vision impairment (OR = 1.19, 95% CI 1.05–1.34, $p = 0.005$, $I^2 = 0\%$, $p = 0.65$) and also in people with both distance and near vision impairments (OR = 3.19, 95% CI 0.93–10.96, $p = 0.07$, $I^2 = 96\%$, $p < 0.0001$) (test for subgroup difference: $Chi^2 = 8.14$, $p = 0.02$) (Fig 15).

3.5. Meta-regression analysis

To explore the potential sources of heterogeneity and examine the moderating role of age on the relationship between vision impairment and the performance of individuals in ADL and IADL, meta-regression analysis was performed. Age was used as the primary moderator variable in the regression model. The analysis revealed a significant negative association between age and both ADL and IADL performance. For ADL, the slope was -0.0147 (95% CI: -0.0179 to -0.0116, $p < 0.001$; S2 Fig), indicating that for every one-year increase in age, ADL performance decreased by an average of 0.0147 units. For IADL, the slope was -0.0047 (95% CI: -0.0088 to -0.0005, p = 0.031; S3 Fig), suggesting that IADL performance also declined with age, though the effect size was smaller compared to ADL. These findings highlight the significant moderating impact of age on functional performance, particularly in individuals with vision impairment.

4. Discussion

Our study shows strong evidence that vision impairment is associated and correlated with higher difficulties in ADL and IADL. The results of the present systematic review and meta-analysis also revealed that the poorer the vision impairment, the more severe the ADL and IADL disability exists in adults and older adults. We found that the association between vision impairment and difficulties in IADL is higher in studies with self-reported vision assessment compared with studies that objectively assessed vision impairment. We also found that the

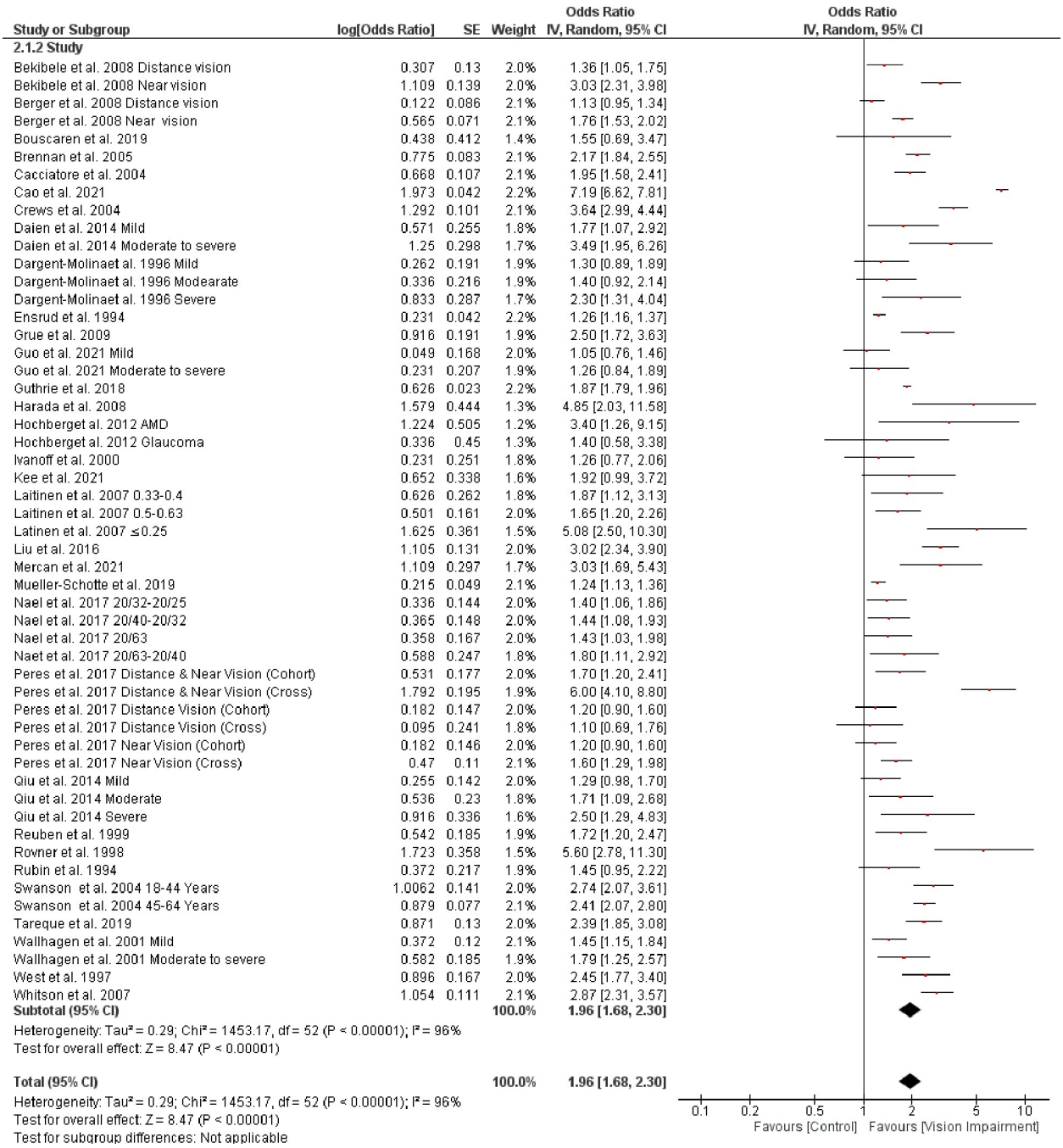


Fig 10. Forest plot of the association between vision impairment and difficulties with instrumental activity of daily living.

https://doi.org/10.1371/journal.pone.0317452.g010

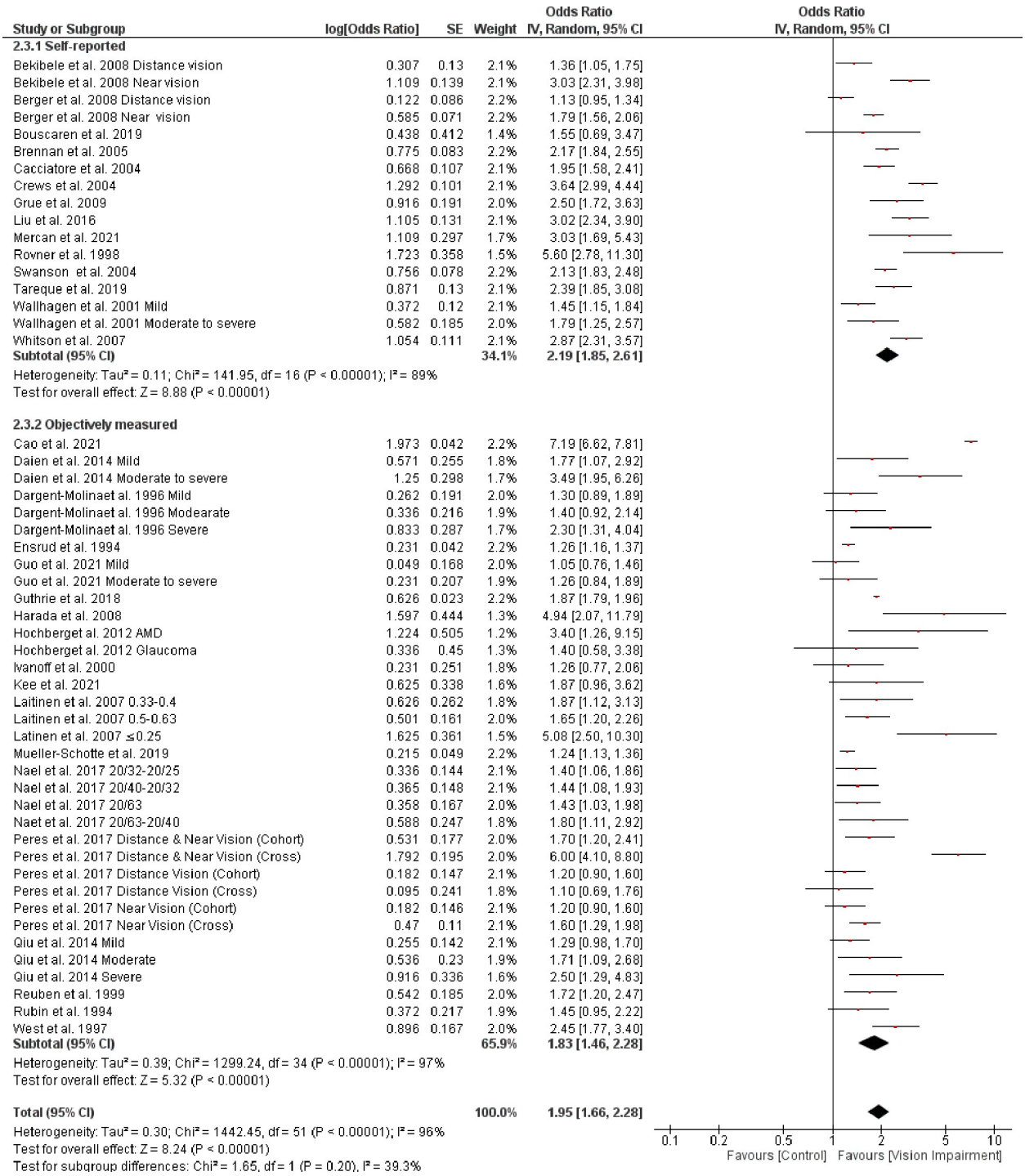


Fig 11. Forest plot of the association between vision impairment and difficulties with instrumental activity of daily living based on different vision assessments.

https://doi.org/10.1371/journal.pone.0317452.g011

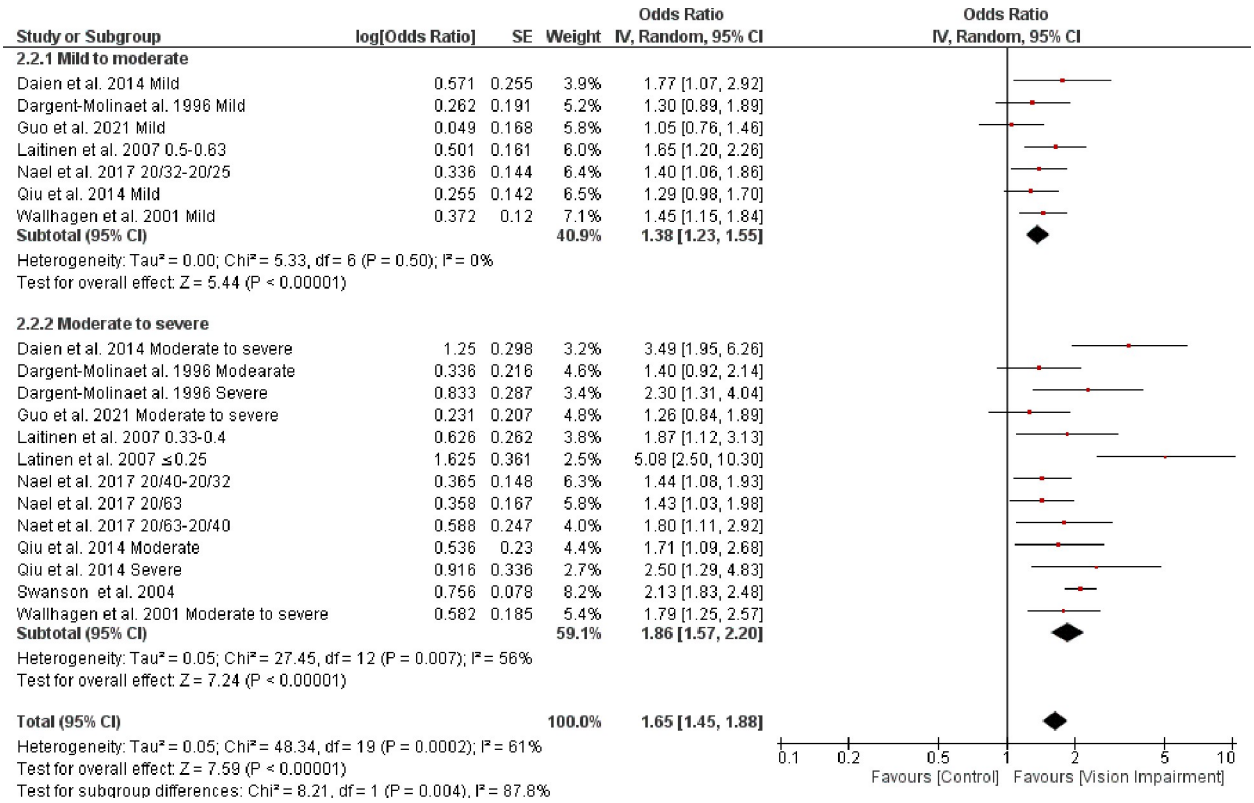


Fig 12. Forest plot of the association between vision impairment and difficulties with instrumental activity of daily living based on severity of vision assessments.

https://doi.org/10.1371/journal.pone.0317452.g012

association between vision impairment and difficulties in ADL and IADL is higher in people with near vision impairment compared with people with only distance vision impairment.

Vision plays an important role in performing activities of daily living by continuously providing information about environment, and body movement and position to the nervous system [66]. People with vision impairment experience difficulties in carrying out reading, leisure activities, and activities of daily living [12, 43, 51, 56, 64, 67]. Vision impairment leads to reduction in the proprioception and vestibular inputs that are required for leisure activities, and activities of daily living [68, 69]. Therefore, it is important to ensure that vision impairment in adults and older adults is adequately treated or corrected, especially among those with ADL and IADL difficulties, in order to limit limitations of vision impairment on their lives. Among included studies in the present meta-analysis, only Park et al. 2015 analyzed the individual components of ADL and found significant higher prevalence of the bathing dimension than the healthy participants [59]. More studies are warranted to demonstrate which components of ADL and IADL are more affected from vision impairment.

Vision impairment affects quality of life and increases the risk of death, thus those with vision impairment require promotional, preventive, treatment, and rehabilitative interventions [1, 70]. The majority of individuals with vision impairment have some useful residual vision and would benefit from low-vision rehabilitation eye care health services [67]. Vision rehabilitation services involves the provision of devices to enhance residual vision, and devices or training techniques for performing tasks and daily activities without reliance on vision [67, 71]. Accordingly, The Lancet Global Health Commission on Global Eye Health emphasizes the importance of integrating prevention, treatment, and rehabilitation services for various eye

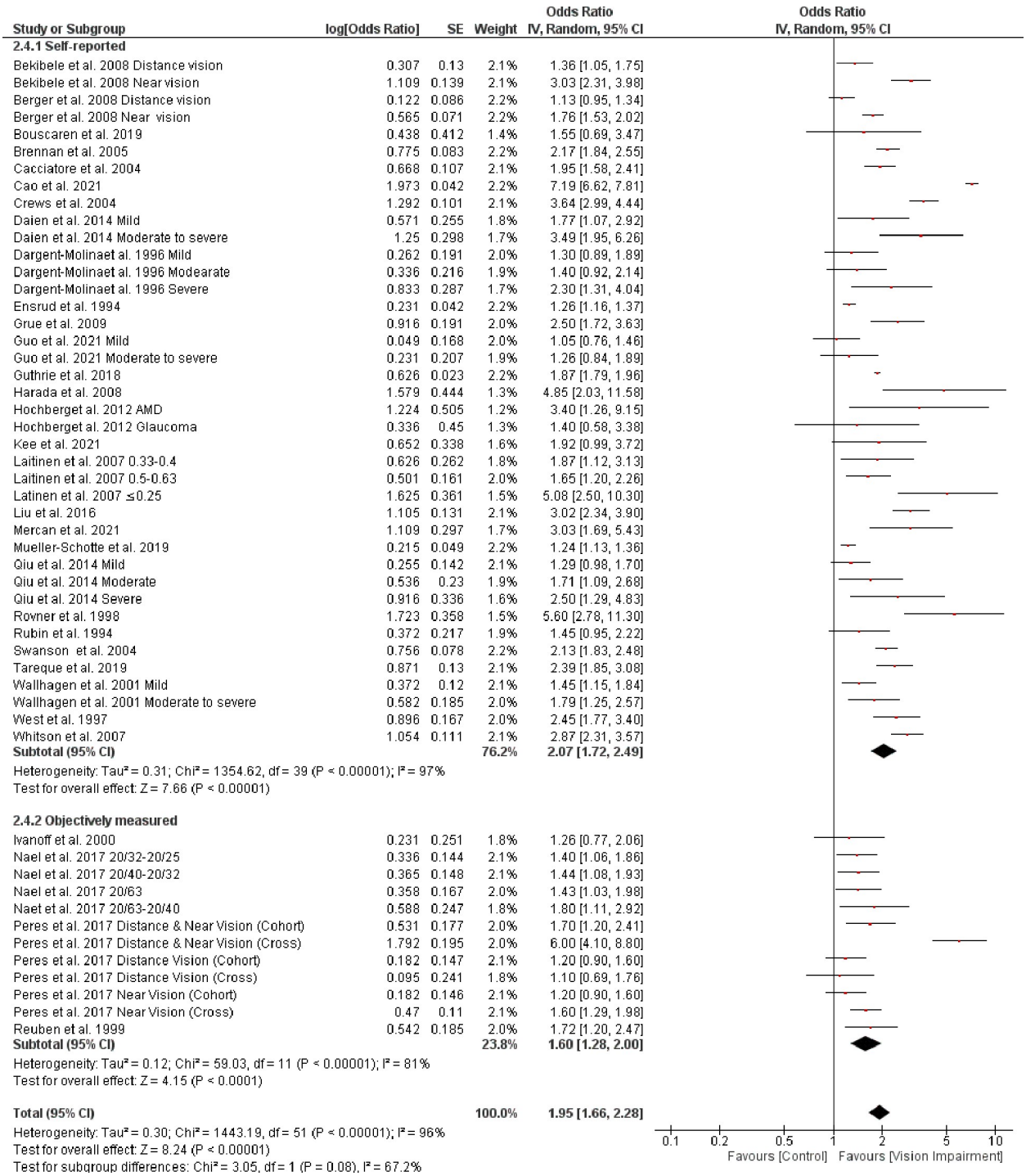


Fig 13. Forest plot of the association between vision impairment and difficulties with instrumental activity of daily living based on different assessments of IADL.

https://doi.org/10.1371/journal.pone.0317452.g013

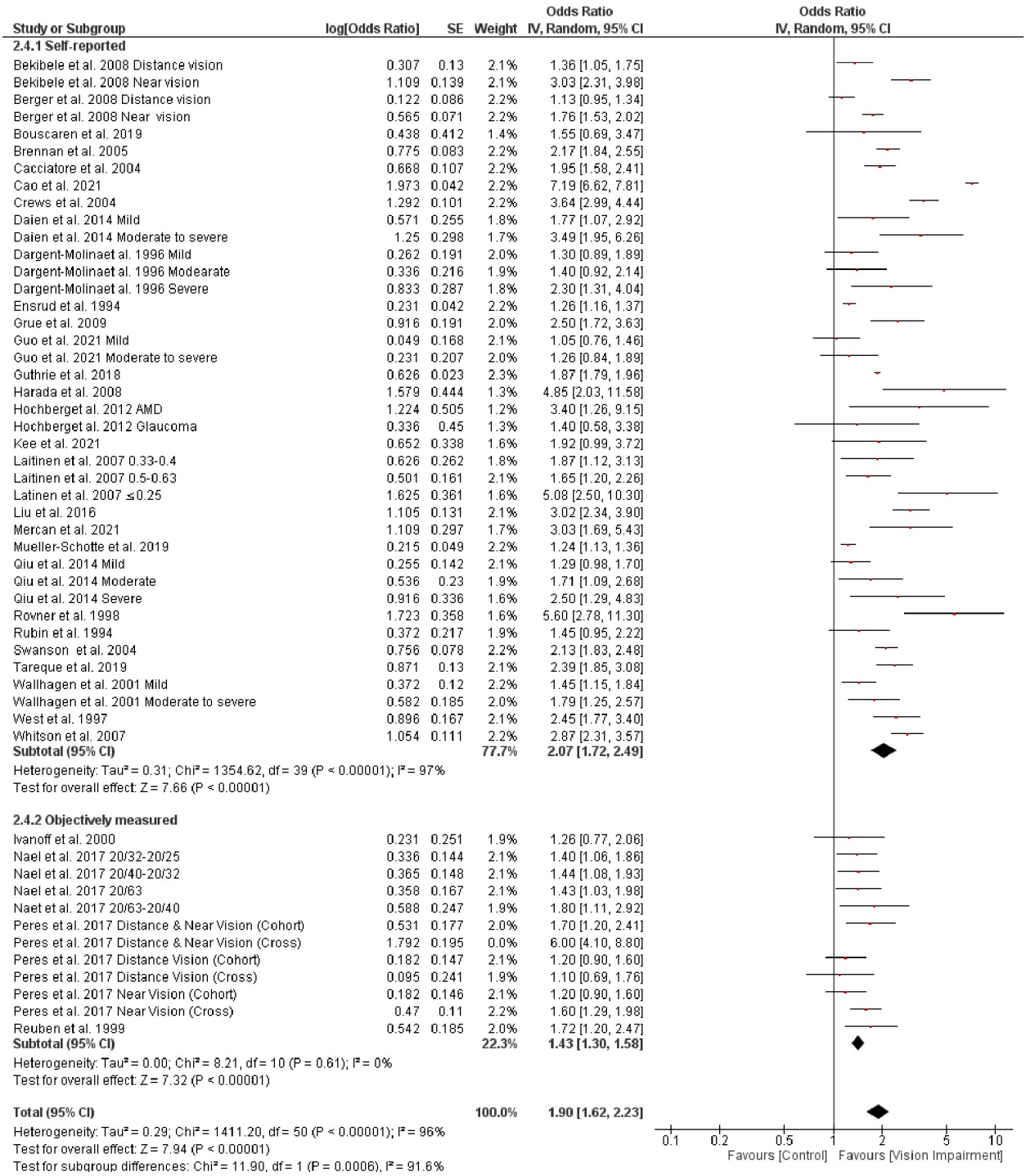


Fig 14. Sensitivity analysis for the association between vision impairment and difficulties with instrumental activity of daily living based on different vision impairment characteristics.

https://doi.org/10.1371/journal.pone.0317452.g014

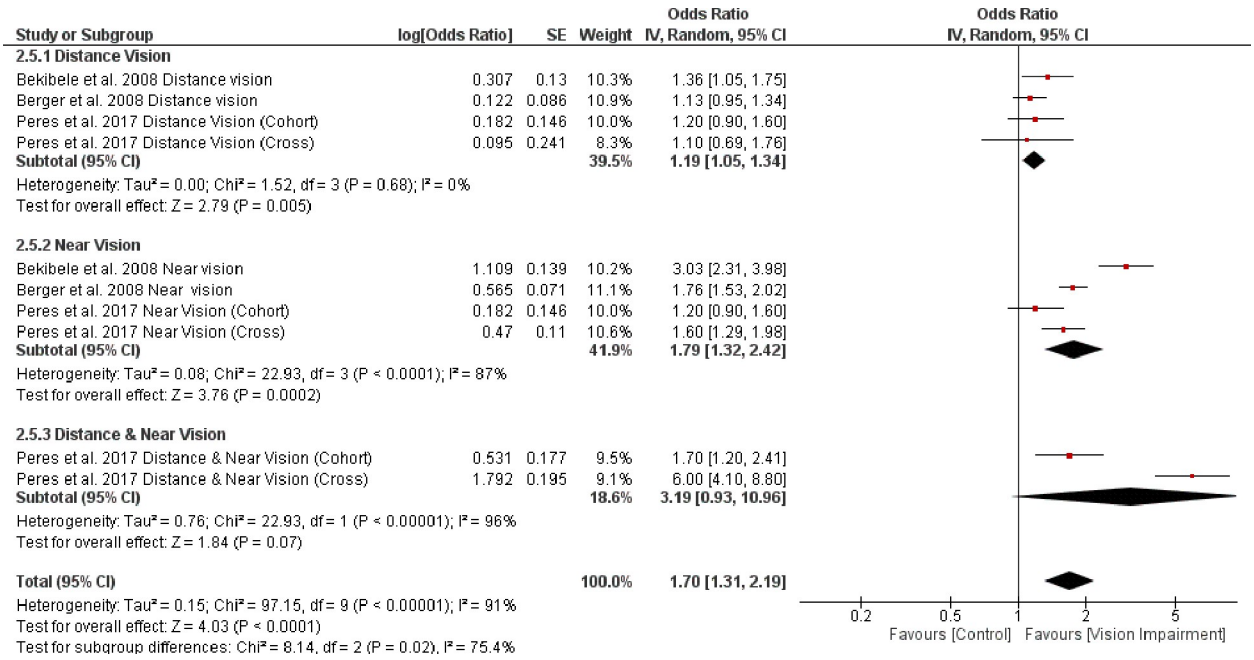


Fig 15. Forest plot of the association between vision impairment and difficulties with instrumental activity of daily living based on different vision impairment characteristics.

https://doi.org/10.1371/journal.pone.0317452.g015

conditions into national health strategies, aligning them with the principles of universal health coverage [3]. Vision rehabilitation centers play a critical role in supporting individuals with vision disabilities by enabling them to attain and maintain independence and optimal functionality [3, 72]. These centers should prioritize services that enhance daily living activities, prevent accidents, and promote overall physical and mental wellbeing [3].

This systematic review and meta-analysis has a number of limitations. First, significant statistical heterogeneity was observed in the results, which can be attributed to variations in patient characteristics, vision assessment methods and definition, and the different ADL and IADL assessment tools used across studies. This heterogeneity arises not only from measurement error but also from the inherent differences in study designs, as detailed in Table 1. While we addressed this issue through subgroup analysis based on the different ADL and IADL measures, we have further discussed these differences to clarify the sources of heterogeneity and their potential impact on the findings. Second, different types of visual acuity charts were used in included studies to assess the associations between vision impairment and ADL and IADL difficulties. Third, extracted data on the difficulties in ADL and IADL in most of the included studies were based on self-reported information. Future studies should consider utilizing objective assessment of ADL and IADL by a trained neuropsychologist, occupational therapist, or health-related expert.

The results of the current systematic review and meta-analysis by using several statistical methods indicates that vision impairment is significantly associated with difficulties in functioning in a wide range of everyday activities, even for a minimal vision impairment level. This suggests that vision impairment is a predictive factor for accelerated deterioration in physical functioning, mainly for activities in daily living. The current systematic review and meta-analysis indicates that vision impairment remains an urgent and increasingly important public health priority.

Supporting information

S1 Checklist. PRISMA 2020 checklist.
(DOCX)

S2 Checklist. MOOSE checklist.
(DOCX)

S1 Table. Literature search strategy.
(DOCX)

S2 Table. Characteristics of individual studies.
(XLSX)

S3 Table. A list of the excluded studies and reasons for their exclusion.
(DOCX)

S4 Table. Quality assessment and publication bias evaluation of included study using the Newcastle-Ottawa Scale (NOS).
(DOCX)

S1 Fig. Funnel plot for publication bias.
(DOCX)

S2 Fig. Meta-regression analysis for the association between vision impairment and difficulties with activity of daily living based on age.
(DOCX)

S3 Fig. Meta-regression analysis for the association between vision impairment and difficulties with instrumental activity of daily living based on age.
(DOCX)

Author Contributions

Conceptualization: Masoud Rahmati, Mapa Prabhath Piyasena, Shahina Pardhan.

Data curation: Masoud Rahmati, Dong Keon Yon, Mapa Prabhath Piyasena, Shahina Pardhan.

Formal analysis: Masoud Rahmati, Dong Keon Yon, Hayeon Lee, Mapa Prabhath Piyasena, Shahina Pardhan.

Funding acquisition: Shahina Pardhan.

Investigation: Masoud Rahmati, Lee Smith, Laurent Boyer, Guillaume Fond, Dong Keon Yon, Hayeon Lee, Tarnjit Sehmbi, Mapa Prabhath Piyasena, Shahina Pardhan.

Methodology: Masoud Rahmati, Lee Smith, Laurent Boyer, Guillaume Fond, Dong Keon Yon, Hayeon Lee, Tarnjit Sehmbi, Shahina Pardhan.

Project administration: Masoud Rahmati, Lee Smith, Shahina Pardhan.

Resources: Masoud Rahmati, Shahina Pardhan.

Software: Guillaume Fond, Dong Keon Yon, Tarnjit Sehmbi, Shahina Pardhan.

Supervision: Masoud Rahmati, Lee Smith, Laurent Boyer, Mapa Prabhath Piyasena, Shahina Pardhan.

Validation: Masoud Rahmati, Laurent Boyer, Guillaume Fond, Hayeon Lee.

Visualization: Mapa Prabhath Piyasena, Shahina Pardhan.

Writing – original draft: Masoud Rahmati, Lee Smith, Laurent Boyer, Guillaume Fond, Dong Keon Yon, Hayeon Lee, Tarnjit Sehmbi, Mapa Prabhath Piyasena, Shahina Pardhan.

Writing – review & editing: Masoud Rahmati, Lee Smith, Laurent Boyer, Guillaume Fond, Dong Keon Yon, Hayeon Lee, Tarnjit Sehmbi, Mapa Prabhath Piyasena, Shahina Pardhan.

References

1. Bourne R, Steinmetz JD, Flaxman S, Briant PS, Taylor HR, Resnikoff S, et al. Trends in prevalence of blindness and distance and near vision impairment over 30 years: an analysis for the Global Burden of Disease Study. The Lancet global health. 2021; 9(2):e130–e43. https://doi.org/10.1016/S2214-109X(20)30425-3 PMID: 33275950.
2. Steinmetz JD, Bourne RR, Briant PS, Flaxman SR, Taylor HR, Jonas JB, et al. Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. The Lancet Global Health. 2021; 9(2):e144–e60. https://doi.org/10.1016/S2214-109X(20)30489-7 PMID: 33275949.
3. Burton MJ, Ramke J, Marques AP, Bourne RRA, Congdon N, Jones I, et al. The Lancet Global Health Commission on Global Eye Health: vision beyond 2020. Lancet Glob Health. 2021; 9(4):e489–e551. Epub 20210216. https://doi.org/10.1016/S2214-109X(20)30488-5 PMID: 33607016.
4. Rahmati M, Smith L, Lee H, Boyer L, Fond G, Yon DK, et al. Associations between vision impairment and eye diseases with dementia, dementia subtypes and cognitive impairment: An umbrella review. Ageing Research Reviews. 2024:102523. https://doi.org/10.1016/j.arr.2024.102523 PMID: 39369799.
5. Mlinac ME, Feng MC. Assessment of Activities of Daily Living, Self-Care, and Independence. Arch Clin Neuropsychol. 2016; 31(6):506–16. Epub 20160729. https://doi.org/10.1093/arclin/acw049 PMID: 27475282.
6. Rahmati M, Keshvari M, Koyanagi A, Yon DK, Lee SW, Shin JI, Smith L. The effectiveness of community ageing in place, advancing better living for elders as a biobehavioural environmental approach for disability among low-income older adults: a systematic review and meta-analysis. Age and Ageing. 2023; 52(4):afad053. https://doi.org/10.1093/ageing/afad053 PMID: 37078754.
7. Berger S, Porell F. The association between low vision and function. Journal of Aging and Health. 2008; 20(5):504–25. https://doi.org/10.1177/0898264308317534 PMID: 18436856.
8. Chan YM, Sahril N, Chan YY, Ab Wahab NA, Shamsuddin N, Ismail MZH. Vision and hearing impairments affecting activities of daily living among Malaysian older adults by gender. International journal of environmental research and public health. 2021; 18(12):6271. https://doi.org/10.3390/ijerph18126271 PMID: 34200564.
9. Dijkhuizen A, Hilgenkamp TI, Krijnen WP, van der Schans CP, Waninge A. The impact of visual impairment on the ability to perform activities of daily living for persons with severe/profound intellectual disability. Res Dev Disabil. 2016; 48:35–42. Epub 20151102. https://doi.org/10.1016/j.ridd.2015.10.001 PMID: 26529065.
10. Falahaty K, Cheong LS, Isa MBHM. Disability among elderly people with visual impairment in two welfare homes in Malaysia. Biomedical & Pharmacology Journal. 2015; 8(2):1369. https://doi.org/10.13005/bpj/897
11. Kee QT, Abd Rahman MH, Mohamad Fadzil N, Mohammed Z, Shahar S. The impact of near visual impairment on instrumental activities of daily living among community-dwelling older adults in Selangor. BMC research notes. 2021; 14(1):1–6. https://doi.org/10.1186/s13104-021-05813-3 PMID: 34689826.
12. Mercan Y, Selçuk KT, Sayılan AA. The relationship between types of physical disabilities and the Instrumental Activities of Daily Living (IADL) in the elderly. Family Medicine and Primary Care Review. 2021. https://doi.org/10.5114/fmpcr.2021.103153
13. Verbeek E, Drewes Y, Gussekloo J. Visual impairment as a predictor for deterioration in functioning: the Leiden 85-plus Study. BMC geriatrics. 2022; 22(1):397. https://doi.org/10.1186/s12877-022-03071-x PMID: 35524168.
14. Zhang C, Zhang X, Zhang H, Zeng P, Yin P, Li Z, et al. Psychometric properties of the Barthel Index for evaluating physical function among Chinese oldest-old. JCSM Clinical Reports. 2022; 7(2):33–43. https://doi.org/10.1002/crt2.47

15. Higgins JP, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011; 343:d5928. Epub 20111018. https://doi.org/10.1136/bmj.d5928 PMID: 22008217.

16. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA. 2000; 283(15):2008–12. https://doi.org/10.1001/jama.283.15.2008 PMID: 10789670.

17. Eriksen MB, Frandsen TF. The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: a systematic review. Journal of the Medical Library Association: JMLA. 2018; 106(4):420. https://doi.org/10.5195/jmla.2018.345 PMID: 30271283

18. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol. 2010; 25(9):603–5. Epub 20100722. https://doi.org/10.1007/s10654-010-9491-z PMID: 20652370.

19. Rahmati M, Molanouri Shamsi M, Woo W, Koyanagi A, Won Lee S, Keon Yon D, et al. Effects of physical rehabilitation interventions in COVID-19 patients following discharge from hospital: A systematic review. J Integr Med. 2023; 21(2):149–58. Epub 20230120. https://doi.org/10.1016/j.joim.2023.01.003 PMID: 36717302.

20. Stijnen T, Hamza TH, Ozdemir P. Random effects meta-analysis of event outcome in the framework of the generalized linear mixed model with applications in sparse data. Stat Med. 2010; 29(29):3046–67. https://doi.org/10.1002/sim.4040 PMID: 20827667.

21. Rahmati M, Yon DK, Lee SW, Udeh R, McEVoy M, Kim MS, et al. New-onset type 1 diabetes in children and adolescents as postacute sequelae of SARS-CoV-2 infection: a systematic review and meta-analysis of cohort studies. Journal of medical virology. 2023; 95(6):e28833. https://doi.org/10.1002/jmv.28833 PMID: 37264687.

22. Van Houwelingen HC, Zwinderman KH, Stijnen T. A bivariate approach to meta-analysis. Stat Med. 1993; 12(24):2273–84. https://doi.org/10.1002/sim.4780122405 PMID: 7907813.

23. Rahmati M, Lee S, Yon DK, Lee SW, Udeh R, McEvoy M, et al. Physical activity and prevention of mental health complications: An umbrella review. Neurosci Biobehav Rev. 2024; 160:105641. Epub 20240326. https://doi.org/10.1016/j.neubiorev.2024.105641 PMID: 38527637.

24. Rahmati M, Smith L, Boyer L, Fond G, Yon DK, Lee H, et al. Factors Affecting Global Adherence for the Uptake of Diabetic Retinopathy Screening: A Systematic Review and Meta-Analysis. Am J Ophthalmol. 2024; 268:94–107. Epub 20240802. https://doi.org/10.1016/j.ajo.2024.07.028 PMID: 39094991.

25. Schoonjans F, Zalata A, Depuydt CE, Comhaire FH. MedCalc: a new computer program for medical statistics. Comput Methods Programs Biomed. 1995; 48(3):257–62. https://doi.org/10.1016/0169-2607(95)01703-8 PMID: 8925653.

26. Rahmati M, McCarthy JJ, Malakoutinia F. Myonuclear permanence in skeletal muscle memory: a systematic review and meta-analysis of human and animal studies. J Cachexia Sarcopenia Muscle. 2022; 13(5):2276–97. Epub 20220812. https://doi.org/10.1002/jcsm.13043 PMID: 35961635.

27. Rahmati M, Fatemi R, Yon DK, Lee SW, Koyanagi A, Il Shin J, Smith L. The effect of adherence to high-quality dietary pattern on COVID-19 outcomes: A systematic review and meta-analysis. J Med Virol. 2023; 95(1):e28298. Epub 20221118. https://doi.org/10.1002/jmv.28298 PMID: 36367218.

28. Crews JE, Campbell VA. Vision impairment and hearing loss among community-dwelling older Americans: implications for health and functioning. American journal of public health. 2004; 94(5):823–9. https://doi.org/10.2105/ajph.94.5.823 PMID: 15117707.

29. Grue EV, Ranhoff AH, Noro A, Finne-Soveri H, Jensdottir AB, Ljunggren G, et al. Vision and hearing impairments and their associations with falling and loss of instrumental activities in daily living in acute hospitalized older persons in five Nordic hospitals. Scandinavian journal of caring sciences. 2009; 23(4):635–43. https://doi.org/10.1111/j.1471-6712.2008.00654.x PMID: 19068040.

30. Rovner BW, Ganguli M. Depression and disability associated with impaired vision: the MoVies Project. J Am Geriatr Soc. 1998; 46(5):617–9. https://doi.org/10.1111/j.1532-5415.1998.tb01080.x PMID: 9588377.

31. Tareque MI, Chan A, Saito Y, Ma S, Malhotra R. The Impact of Self-Reported Vision and Hearing Impairment on Health Expectancy. J Am Geriatr Soc. 2019; 67(12):2528–36. Epub 20190814. https://doi.org/10.1111/jgs.16086 PMID: 31411348.

32. Bekibele CO, Gureje O. Self-reported visual impairment and impact on vision-related activities in an elderly Nigerian population: report from the Ibadan study of ageing. Ophthalmic Epidemiol. 2008; 15(4):250–6. https://doi.org/10.1080/09286580802336583 PMID: 18780258.

33. Bouscaren N, Yildiz H, Dartois L, Vercambre M, Boutron-Ruault MC. Decline in instrumental activities of daily living over 4-year: the association with hearing, visual and dual sensory impairments among

non-institutionalized women. The journal of nutrition, health & aging. 2019; 23:687–93. https://doi.org/10.1007/s12603-019-1231-9 PMID: 31560024.

34. Brennan M, Horowitz A, Su YP. Dual sensory loss and its impact on everyday competence. Gerontologist. 2005; 45(3):337–46. https://doi.org/10.1093/geront/45.3.337 PMID: 15933274.

35. Cacciatore F, Abete P, Maggi S, Luchetti G, Calabrese C, Viati L, et al. Disability and 6-year mortality in elderly population. Role of visual impairment. Aging Clin Exp Res. 2004; 16(5):382–8. https://doi.org/10.1007/BF03324568 PMID: 15636464.

36. Cimarolli VR, Jopp DS. Sensory impairments and their associations with functional disability in a sample of the oldest-old. Quality of Life Research. 2014; 23:1977–84. https://doi.org/10.1007/s11136-014-0657-0 PMID: 24682668.

37. Liu PL, Cohen HJ, Fillenbaum GG, Burchett BM, Whitson HE. Association of Co-Existing Impairments in Cognition and Self-Rated Vision and Hearing With Health Outcomes in Older Adults. Gerontol Geriatr Med. 2016; 2:2333721415623495. Epub 20160119. https://doi.org/10.1177/2333721415623495 PMID: 27054148.

38. Swanson MW, McGwin G. Visual impairment and functional status from the 1995 National Health Interview Survey on Disability. Ophthalmic Epidemiol. 2004; 11(3):227–39. https://doi.org/10.1080/09286580490514540 PMID: 15370554.

39. Wallhagen MI, Strawbridge WJ, Shema SJ, Kurata J, Kaplan GA. Comparative impact of hearing and vision impairment on subsequent functioning. J Am Geriatr Soc. 2001; 49(8):1086–92. https://doi.org/10.1046/j.1532-5415.2001.49213.x PMID: 11555071.

40. Whitson HE, Cousins SW, Burchett BM, Hybels CF, Pieper CF, Cohen HJ. The combined effect of visual impairment and cognitive impairment on disability in older people. J Am Geriatr Soc. 2007; 55(6):885–91. https://doi.org/10.1111/j.1532-5415.2007.01093.x PMID: 17537089.

41. Daien V, Peres K, Villain M, Colvez A, Carriere I, Delcourt C. Visual acuity thresholds associated with activity limitations in the elderly. The Pathologies Oculaires Liées à l'Age study. Acta Ophthalmologica. 2014; 92(7):e500–e6. https://doi.org/10.1111/aos.12335 PMID: 24428942.

42. Horowitz A. Vision impairment and functional disability among nursing home residents. The Gerontologist. 1994; 34(3):316–23. https://doi.org/10.1093/geront/34.3.316 PMID: 8076872.

43. Nael V, Peres K, Carriere I, Daien V, Scherlen AC, Arleo A, et al. Visual Impairment, Undercorrected Refractive Errors, and Activity Limitations in Older Adults: Findings From the Three-City Alienor Study. Invest Ophthalmol Vis Sci. 2017; 58(4):2359–65. https://doi.org/10.1167/iovs.17-21525 PMID: 28437525.

44. Reuben DB, Mui S, Damesyn M, Moore AA, Greendale GA. The prognostic value of sensory impairment in older persons. J Am Geriatr Soc. 1999; 47(8):930–5. https://doi.org/10.1111/j.1532-5415.1999.tb01286.x PMID: 10443852.

45. Rokicki W, Drozdzowska B, Czekajło A, Grzeszczak W, Wiktor K, Majewski W, et al. Relationship between visual status and functional status and the risk of falls in women. The RAC-OST-POL study. Archives of medical science. 2016; 12(6):1232–8. https://doi.org/10.5114/aoms.2015.55146 PMID: 27904513.

46. Guo X, Arsiwala LT, Dong Y, Mihailovic A, Ramulu PY, Sharrett AR, et al. Visual Function, Physical Function, and Activities of Daily Living in Two Aging Communities. Transl Vis Sci Technol. 2021; 10(14):15. https://doi.org/10.1167/tvst.10.14.15 PMID: 34913953.

47. Hochberg C, Maul E, Chan ES, Van Landingham S, Ferrucci L, Friedman DS, Ramulu PY. Association of vision loss in glaucoma and age-related macular degeneration with IADL disability. Invest Ophthalmol Vis Sci. 2012; 53(6):3201–6. Epub 20120531. https://doi.org/10.1167/iovs.12-9469 PMID: 22491415.

48. West SK, Munoz B, Rubin GS, Schein OD, Bandeen-Roche K, Zeger S, et al. Function and visual impairment in a population-based study of older adults. The SEE project. Salisbury Eye Evaluation. Invest Ophthalmol Vis Sci. 1997; 38(1):72–82. https://doi.org/9008632. PMID: 9008632

49. Dargent-Molina P, Hays M, Breart G. Sensory impairments and physical disability in aged women living at home. International journal of epidemiology. 1996; 25(3):621–9. https://doi.org/10.1093/ije/25.3.621 PMID: 8671565.

50. Laitinen A, Sainio P, Koskinen S, Rudanko S-L, Laatikainen L, Aromaa A. The association between visual acuity and functional limitations: findings from a nationally representative population survey. Ophthalmic Epidemiology. 2007; 14(6):333–42. https://doi.org/10.1080/01658100701473713 PMID: 18161606.

51. Haymes SA, Johnston AW, Heyes AD. Relationship between vision impairment and ability to perform activities of daily living. Ophthalmic and Physiological Optics. 2002; 22(2):79–91. https://doi.org/10.1046/j.1475-1313.2002.00016.x PMID: 12014491.

52. Ross CK, Stelmack JA, Stelmack TR, Fraim M. Preliminary examination of the reliability and relation to clinical state of a measure of low vision patient functional status. Optom Vis Sci. 1991; 68(12):918–23. https://doi.org/10.1097/00006324-199112000-00002 PMID: 1787948.

53. Ensrud KE, Nevitt MC, Yunis C, Cauley JA, Seeley DG, Fox KM, Cummings SR. Correlates of impaired function in older women. J Am Geriatr Soc. 1994; 42(5):481–9. https://doi.org/10.1111/j.1532-5415.1994.tb04968.x PMID: 8176141.

54. Ivanoff SD, Sonn U, Lundgren-Lindqvist B, Sjöstrand J, Steen B. Disability in daily life activities and visual impairment: a population study of 85-year-old people living at home. Scandinavian Journal of Occupational Therapy. 2000; 7(4):148–55. https://doi.org/10.1080/110381200300008689

55. Keller BK, Morton JL, Thomas VS, Potter JF. The effect of visual and hearing impairments on functional status. J Am Geriatr Soc. 1999; 47(11):1319–25. https://doi.org/10.1111/j.1532-5415.1999.tb07432.x PMID: 10573440.

56. Peres K, Matharan F, Daien V, Nael V, Edjolo A, Bourdel-Marchasson Is, et al. Visual Loss and Subsequent Activity Limitations in the Elderly: The French Three-City Cohort. Am J Public Health. 2017; 107(4):564–9. Epub 20170216. https://doi.org/10.2105/AJPH.2016.303631 PMID: 28207341.

57. Rubin GS, Roche KB, Prasada-Rao P, Fried LP. Visual impairment and disability in older adults. Optom Vis Sci. 1994; 71(12):750–60. https://doi.org/10.1097/00006324-199412000-00005 PMID: 7898882.

58. Wahl HW, Schilling O, Oswald F, Heyl V. Psychosocial consequences of age-related visual impairment: comparison with mobility-impaired older adults and long-term outcome. J Gerontol B Psychol Sci Soc Sci. 1999; 54(5):P304–16. https://doi.org/10.1093/geronb/54b.5.p304 PMID: 10542823.

59. Park S, Kho YL, Kim H-J, Kim J, Lee E-H. Impact of glaucoma on quality of life and activities of daily living. Hong Kong Journal of Occupational Therapy. 2015; 25:39–44. https://doi.org/10.1016/j.hkjot.2015.04.002

60. Cao G, Wang K, Han L, Zhang Q, Yao S, Chen Z, et al. Visual trajectories and risk of physical and cognitive impairment among older Chinese adults. Journal of the American Geriatrics Society. 2021; 69(10):2877–87. https://doi.org/10.1111/jgs.17311 PMID: 34111310.

61. Mueller-Schotte S, Zuithoff NPA, van der Schouw YT, Schuurmans MJ, Bleijenberg N. Trajectories of Limitations in Instrumental Activities of Daily Living in Frail Older Adults With Vision, Hearing, or Dual Sensory Loss. J Gerontol A Biol Sci Med Sci. 2019; 74(6):936–42. https://doi.org/10.1093/gerona/gly155 PMID: 29982391.

62. Qiu M, Wang SY, Singh K, Lin SC. Association between visual field defects and quality of life in the United States. Ophthalmology. 2014; 121(3):733–40. https://doi.org/10.1016/j.ophtha.2013.09.043 PMID: 24342021.

63. Guthrie DM, Davidson JG, Williams N, Campos J, Hunter K, Mick P, et al. Combined impairments in vision, hearing and cognition are associated with greater levels of functional and communication difficulties than cognitive impairment alone: Analysis of interRAI data for home care and long-term care recipients in Ontario. PloS one. 2018; 13(2):e0192971. https://doi.org/10.1371/journal.pone.0192971 PMID: 29447253.

64. Harada S, Nishiwaki Y, Michikawa T, Kikuchi Y, Iwasawa S, Nakano M, et al. Gender difference in the relationships between vision and hearing impairments and negative well-being. Preventive medicine. 2008; 47(4):433–7. https://doi.org/10.1016/j.ypmed.2008.06.011 PMID: 18619483.

65. Lam BL, Christ SL, Zheng DD, West SK, Munoz BE, Swenor BK, Lee DJ. Longitudinal relationships among visual acuity and tasks of everyday life: the Salisbury Eye Evaluation study. Investigative ophthalmology & visual science. 2013; 54(1):193–200. https://doi.org/10.1167/iovs.12-10542 PMID: 23221066.

66. Lord SR. Visual risk factors for falls in older people. Age Ageing. 2006; 35 Suppl 2(suppl_2):ii42–ii5. https://doi.org/10.1093/ageing/afl085 PMID: 16926203.

67. Hinds A, Sinclair A, Park J, Suttie A, Paterson H, Macdonald M. Impact of an interdisciplinary low vision service on the quality of life of low vision patients. Br J Ophthalmol. 2003; 87(11):1391–6. https://doi.org/10.1136/bjo.87.11.1391 PMID: 14609841.

68. Cutfield NJ, Scott G, Waldman AD, Sharp DJ, Bronstein AM. Visual and proprioceptive interaction in patients with bilateral vestibular loss. Neuroimage Clin. 2014; 4:274–82. Epub 20140104. https://doi.org/10.1016/j.nicl.2013.12.013 PMID: 25061564.

69. Tsang WW, Hui-Chan CW. Effects of exercise on joint sense and balance in elderly men: Tai Chi versus golf. Med Sci Sports Exerc. 2004; 36(4):658–67. https://doi.org/10.1249/01.mss.0000122077.87090.2e PMID: 15064594.

70. Ehrlich JR, Ramke J, Macleod D, Burn H, Lee CN, Zhang JH, et al. Association between vision impairment and mortality: a systematic review and meta-analysis. The Lancet Global Health. 2021; 9(4):e418–e30. https://doi.org/10.1016/S2214-109X(20)30549-0 PMID: 33607015.

71. McCabe P, Nason F, Demers Turco P, Friedman D, Seddon JM. Evaluating the effectiveness of a vision rehabilitation intervention using an objective and subjective measure of functional performance. Ophthalmic Epidemiol. 2000; 7(4):259–70. https://doi.org/10.1076/opep.7.4.259.4173 PMID: 11262673.

72. Eden K, Doliszny K, Shukla R, Foster J, Bona M. Improving access to vision rehabilitation care: implementation of the South East Ontario Vision Rehabilitation Service. Can J Ophthalmol. 2024; 59(5): e471–e8. Epub 20230921. https://doi.org/10.1016/j.jcjo.2023.08.011 PMID: 37743046.