SYSTEMATIC REVIEW

Risk factors common to leading eye health conditions and major non-communicable diseases: a rapid review and commentary [version 1; peer review: awaiting peer review]

Lisa Keay¹,², Kerrie Ren¹, Helen Nguyen¹, Claire Vajdic³, Michael Odutola³, Rajendra Gyawali¹, Melinda Toomey¹, Ruth Peters⁴, Nicole Ee⁴, Lisa Dillon¹, Maree Hackett², Brandon Ah Tong⁵, Fabrizio D'Esposito⁵, David Faulmann⁵, Matthew Burton⁶, Jacqueline Ramke⁶, Isabelle Jalbert¹

¹School of Optometry and Vision Science, UNSW Sydney, NSW, Australia
²The George Institute for Global Health, Sydney, NSW, Australia
³The Kirby Institute, UNSW Sydney, NSW, Australia
⁴Neuroscience Research Australia, UNSW Sydney, NSW, Australia
⁵The Fred Hollows Foundation, Sydney, NSW, Australia
⁶International Centre for Eye Health, London School of Hygiene & Tropical Medicine, London, UK

Abstract

**Background:** To gain an understanding of the intersection of risk factors between the most prevalent eye health conditions that are associated with vision impairment and non-communicable diseases (NCDs).

**Methods:** A series of rapid reviews of reviews reporting on non-modifiable risk factors, age and sex, and modifiable risk factors, including social determinants, were conducted for five common eye health conditions that are the leading causes of vision impairment globally (refractive error including uncorrected refractive error, cataract, age-related macular degeneration (AMD), glaucoma, and diabetic retinopathy) and five prevalent NCDs (cancer, cardiovascular disease, chronic respiratory disease, dementia, and depressive disorders). Articles published within approximately 5 years to the end of 2019 were identified through expert recommendation, PubMED, Ovid Medline, the Lancet Global Burden of Disease series, the International Agency for Research on Cancer and World Cancer Research Fund.

**Results:** Of 9,213 records identified, 320 records were eligible. Eye health conditions and NCDs share many risk factors. Increased age was found to be the most common shared risk factor, associated with increased risks of AMD, cataract, diabetic retinopathy, glaucoma, refractive error, cancer, cardiovascular disease, chronic obstructive pulmonary disease, and dementia. Other shared risk factors included
smoking, obesity, alcohol consumption (mixed results), and physical activity was protective, though limited evidence was found for eye conditions. Social determinants are well documented as risk factors for NCDs.

**Conclusion:** There is substantial overlap in common established risk factors for the most frequent vision impairing eye conditions and leading NCDs. Increasing efforts should be made to integrate preventative and risk reduction interventions to improve health, with greatest shared benefits for initiatives which aim to reduce smoking, improve diet, and promote physical activity.

**Keywords**
vision impairment, eye health, non-communicable disease, risk factors, social determinants

This article is included in the **Eye Health** gateway.
**Introduction**

People who have vision impairment often also present with chronic non-communicable diseases (NCDs) and thus have competing health priorities. For example, the National Health Interview Survey from the USA found that, among people with vision impairment, there was a high prevalence of chronic conditions including cancer (27%), chronic obstructive pulmonary disease (COPD, 27%), and ‘heart disease’ (39%).

Additionally, people with vision impairment have an approximate 1.5–2-times increased risk of NCDs such as lung cancer (2.1, 95% CI 1.05–3.87), cardiovascular disease (CVD, 1.65 (95% CI 1.44–1.89)), dementia (2.02, 95% CI 1.68–2.43), and depression (1.59, 95% CI 1.4–1.81). A meta-analysis of data from high- and middle-income countries found 25% of people with eye health conditions have significant depressive symptoms. Depressive symptoms have also been shown to be increasingly prevalent with more severe eye health conditions. The prevalence of chronic health conditions in people with vision impairment suggests common contributing factors.

Furthermore, there is evidence that vision impairment can increase the impact of chronic health conditions. For example, a study in China examining the combined effects of sensory loss and dementia found that when people have vision loss, the risk of dementia is 1.5-times higher (1.54, 95% CI 1.27–1.86). Similarly, depression was found in around one-quarter of adults over 65 years with solid tumours receiving chemotherapy, but was 2.5-times more prevalent (2.5, 95% CI 1.4–4.3) among those with vision impairment in addition to their cancer diagnosis. These patterns further suggest vision impairment and general health share common causal pathways.

There is evidence that eye health conditions share common, modifiable, behavioural, and metabolic risk factors such as smoking, alcohol consumption, obesity, diabetes increasing risk and physical activity being protective. These are also known and established risk factors for NCDs. However, the intersection between eye health conditions and NCDs has yet to be systematically investigated. To gain a more complete understanding of this intersection, this rapid review was conducted to identify shared risk factors between five common eye health conditions that can cause vision impairment (refractive error, including uncorrected refractive error, cataract, age-related macular degeneration (AMD), diabetic retinopathy, and glaucoma) and five prevalent NCDs (cancer, CVD, COPD, dementia, and depression). A series of pragmatic, rapid reviews was conducted to appraise and synthesise the available evidence.

**Methods**

We conducted a series of rapid reviews of reviews reporting on two non-modifiable risk factors, age and sex, and modifiable risk factors, including social determinants, for five common eye health conditions and five prevalent NCDs. Social determinants include factors such as educational attainment, socio-economic status and income. The core review question was to document evidence, expressed as pooled odds ratios or risk ratios, for associations between risk factors (age, sex, modifiable risk factors and social determinants) and the five common eye health conditions (refractive error, including uncorrected refractive error, cataract, AMD, diabetic retinopathy, and glaucoma) and five NCDs (cancer, CVD, COPD, dementia, and depression). Each of these conditions was assigned to a team with content expertise. This methodology was adapted from an overview of reviews publication, and follows commonly employed rapid review methods reported by the World Health Organization. Reviews were required to be published between December 2014 and December 2019, report associations between the investigated conditions and risk factors in humans and written in the English language. Searches were conducted by each team separately in December 2019, with synthesis of approximately 5 years of literature to end of 2019.

Due to the large volume of literature reporting risk factors for the five common eye health conditions and five NCDs, we used a pragmatic approach to select the most up to date evidence. The PubMed database was searched to identify risk factors and social determinants for CVDs and COPD. Risk factors and social determinants for dementia were extracted and synthesised from systematic reviews identified through expert recommendation and supplemented by a rapid review. Through expert recommendation, the latest determinations of risk factors for eye health conditions (age and sex), depression, and cancer were synthesised. For example, risk factors for eye health conditions (age and sex) and depression were extracted and synthesised from the Lancet Global Burden of Disease (GBD) series and supplemented by a rapid review using Ovid Medline for eye health conditions and PubMed for depression. Risk factors for cancer were extracted and synthesised from publications by the International Agency for Research on Cancer (IARC) and World Cancer Research Fund (WCRF) and supplemented by a PubMed database search to extract the social determinants.

The most recently published systematic reviews (or overview of systematic reviews where available) were selected to synthesise the most up to date evidence available. Where two publications occurred within the same year or covered the same research question, the publication with the most recent search dates was retained. It should be noted that due to the vast amount of extant literature, only the global top 10 cancers in 2017 (non-melanoma skin, lung, breast, colorectal, prostate, stomach, liver, cervical, non-Hodgkin lymphoma, and bladder cancer) were included in the cancer search,
and only COPD was included in the chronic respiratory diseases search. The CVDs investigated were stroke, coronary heart/artery disease, myocardial infarction, ischaemic heart disease, and mixed/unspecified CVD. Systematic reviews of cross-sectional studies and clinical trials were not included as we focused on risk associations and causality. Furthermore, genetic studies were excluded as these are non-modifiable risk factors. Repository-hosted Extended Data 2 provides further details for each search strategy conducted.\(^{150}\)

All titles and abstracts were screened for relevance by one reviewer, and those selected progressed to full-text review. Data on population, sample size, number, and type of studies included in systematic reviews or meta-analyses, risk factors and pooled estimates were extracted into data tables by one reviewer. The common risk factors between five common eye health conditions and five prevalent NCDs were then identified and synthesised by the content expert teams.

### Results

A total of 9,213 records were identified through expert recommendation and database searches and 8,706 records were excluded at the title and abstract screening stage for not reporting results relevant to the NCD, eye health condition or modifiable risk factors. The remaining 507 were sought for full text review, with an additional nine records identified through a reference list search. These 516 records were assessed for eligibility, where a further 196 studies were rejected for reasons including no relevant data, incorrect study design, overlapping study populations, studies in clinical populations, and studies with a focus on treatment. A total of 320 records are included in this rapid review. Figure 1 shows further details on the number of records identified for each NCD and eye health condition. Data extraction tables can be found in Repository-hosted Extended Data 3.\(^{11}\)

### Non-modifiable risk factors

#### Age

Age was the most common risk factor shared between eye health conditions and NCDs. Age is an established risk factor for many eye health conditions, where prevalence increases sharply with older age. Consequently, regions with an older population have a higher numbers of people with AMD,\(^{12}\) diabetic retinopathy,\(^{13}\) cataract,\(^{14}\) and glaucoma\(^{15}\) compared to regions with a younger population. A combination of age and protective social determinants, specifically time spent outdoors, less near work, and physical activity, contribute to the development of refractive error in childhood. An exponential increase in global myopia prevalence between the ages 0 and 39 years may be due to significant lifestyle changes such as increasing hours of near work (e.g. reading, writing, computer use) related to intensive education or changes in occupations, and urbanisation resulting in reduced time spent outdoors.\(^{16}\)

Similarly, increasing age is strongly associated with cancer whereby adults aged 50 years and older account for 70% of incident cancer cases and 87% of cancer deaths globally, compared to 5% and 1% respectively for children and adolescents.\(^{17}\) Increasing age is also an established risk factor for CVDs, with the risk of stroke reported to increase by between 64% and 70% for every 5 year increase in age after the age of 60 years.\(^{18,19}\) COPD was found to be most prevalent in those aged 60 years and older.\(^{20,21}\) However, there is uncertainty around whether increasing prevalence of COPD with age is an effect of age itself, or due to the higher number of years smoking or being exposed to smoke.\(^{20}\)

Dementia was diagnosed in 10% of those aged 65 years and older, with diagnosis increasing to 30% in those aged 85 years and older.\(^{22}\) No direct association between age and depressive disorders was found.

#### Sex

Sex was not found to be a risk factor for AMD.\(^{23}\)

After menopause, females were reported to have an increased risk of CVD, whereas before menopause, females were somewhat protected from CVDs.\(^{24}\) While obesity is a risk factor for depressive disorders itself, females who are obese throughout life were more at risk of depressive disorders than males who are obese throughout life.\(^{25}\) Furthermore, female college students were 11% more likely to develop depressive disorders compared to their male counterparts.\(^{26}\)

Contrarily, there is a male preponderance for cancer and possibly also COPD. Males accounted for 22% of incident cases and 13% cancer mortality, compared to 18% and 9% respectively for females.\(^{27}\)

Conflicting evidence was observed...
for COPD, with some studies reporting no differences between sexes, while others report males have a higher COPD prevalence in six of the seven World Health Organization regions. There was no evidence found on the association between sex and dementia.

Figure 1. PRISMA flow diagram. Number of records identified for each eye health condition and non-communicable disease discussed. GBD, Global Burden of Disease; IARC, International Agency for Research on Cancer; WCRF, World Cancer Research Fund.
Modifiable behavioural risk factors

Smoking

Smoking is a known and established risk factor for many health conditions, and the most common modifiable risk factor for eye health conditions and NCDs. Smoking is strongly associated with the development of cataract, increasing risk by up to 57%.[32] There was limited evidence for the link between smoking and diabetic retinopathy, where smokers with type 1 diabetes were reported to have increased risk (ranging 23–48%) of diabetic retinopathy, while smokers with type 2 diabetes have reduced risk (ranging 8–32%).[30] There was also limited evidence available for the association between glaucoma and smoking as studies were limited to heavy smoker populations.[31,32] No reported link was found between smoking during pregnancy and children with refractive error.[33] In addition, it should be noted that although no new evidence was published during the period selected for this search, smoking is strongly associated with AMD.[34]

Any former or current smoking was consistently reported as a risk factor for cancer, with the latter having demonstrably greater risk. The most significant risk was for lung cancer, with former and current smokers reported to have increased risk by 213% and between 599–633%, respectively.[35,36] Former smokers have increased risk by between 12% and 83% for bladder, stomach, cervical, liver, and colorectal cancer, whereas current smokers have increased risk by between 29% and 214%.[36–40] There was limited evidence of a link between smoking and breast cancer.[41]

Even one cigarette per day was reported to increase risks for stroke and coronary heart/artery disease by between 52% and 65%, with 20 cigarettes per day increasing risk by up to four-times.[42] There was also strong evidence that current smokers have a 30% increased risk of dementia, however the risk is reduced when people stop smoking.[43]

These odds are slight in comparison to the 400% increased risk of COPD in smokers—whether it be cigarettes, tobacco, or marijuana—compared with non-smokers.[44] However, non-smokers are also at a 44% increased risk of COPD development when exposed to passive smoke for just one hour per day. Constant exposure to passive smoke during childhood and adulthood can also increase COPD risk by 72%.[44] In addition, some studies report children born from mothers who smoked during pregnancy may have had their lung development in utero affected, and thus are at an increased risk of COPD development in later life.[20,45] Passive smoke also increased depressive symptoms between 30% and 60%.[46,47]

Alcohol consumption

Heavy alcohol consumption is strongly associated with the development of cataract and AMD, reported to increase risks by 25%[48] and 20%, respectively.[49] The association between diabetic retinopathy and alcohol consumption is uncertain, with studies reporting no association, protective benefits with wine consumption,[50] and increased risk by 30%.[51]

Alcohol was a consistent risk factor for breast, colorectal and liver cancer, with increased risks ranging from 4% to 114%.[52–54] It is also an established risk factor for CVDs, however studies have conflicting results. Some studies report heavy alcohol consumption increases the risk of stroke, particularly in women,[55] whereas others report low to moderate consumption was protective of stroke as well as coronary heart/artery disease.[55,56] Limited evidence exists on the association between alcohol and ischaemic heart disease,[57] and no reported links between heavy alcohol consumption and COPD, dementia, and depressive disorders were found.

Physical activity

The most consistent factor protective against eye health conditions and NCDs was physical activity. CVDs receive the most benefit from physical activity, reducing risk for all investigated CVDs. Physically active individuals were between 17% and 25% less likely to develop CVDs in comparison to less active individuals.[58,59] In addition, there was strong evidence that increasing levels of cardiorespiratory fitness, a proxy for physical activity, leads to decreasing risk of depressive disorder development. Individuals with poor cardiorespiratory fitness were 80% more likely to develop depressive disorders, while those with medium cardiorespiratory fitness were only 20% more likely than people with high cardiorespiratory fitness.[60,61] There was strong evidence that physical activity can be protective of colorectal cancer, with reduced risks by up to 16%.[52]

Finally, there was limited evidence to support the protective effects of physical activity on dementia,[9] AMD,[62] diabetic retinopathy,[63] and refractive error.[63] This was also the case for breast cancer in post-menopausal women,[64] lung cancer,[65] and liver cancer.[66] There was no evidence of an association between physical activity and stomach cancer, prostate cancer, and non-Hodgkin lymphoma risk.[62]
Sun exposure/time spent outdoors

There was strong evidence that sun exposure is a risk factor for cataract whereby individuals with long-term sun exposure have increased risk of between 19% and 120%. On the contrary, time spent outdoors, which could be a proxy for sun exposure, is protective against the development of refractive error; however, limited evidence exists on its protective effect on refractive error progression. Furthermore, there is conflicting evidence for the association between sun exposure and AMD, where some studies report an association and others no association.

Excessive sun exposure is an established cause of melanoma and non-melanoma skin cancer, increasing risk by 30% and 95–97% respectively. In those who experience sunburn, the risk of melanoma and non-melanoma skin cancer increased by between 83–169% and 41–122%, respectively.

Modifiable metabolic risk factors

Obesity/high BMI

Obesity, a high BMI, or a high body fat percentage was the second-most common shared risk factor identified between eye health conditions and NCDs. Conflicting evidence was found on the association between obesity, a high BMI and diabetic retinopathy, with some studies reporting no association, while others an increased risk of 20%. Some studies have also reported reduced risk of diabetic retinopathy by between 53% and 61% in those who underwent bariatric surgery, a procedure which is usually reserved for individuals with obesity.

A high body fat percentage was strongly associated with breast, colorectal, stomach, and liver cancer. Post-menopausal women with a high BMI were 12% more likely to develop breast cancer than post-menopausal women with a low BMI. High BMI was also shown to increase the risk of colorectal (30%), stomach (80%), and liver cancer (80%). There was limited evidence to suggest those with a high BMI have a higher risk of prostate cancer and non-Hodgkin lymphoma.

Obesity is also an established risk factor for CVDs. Individuals who are obese or have a high BMI are more at risk of developing coronary heart/artery disease (39%) and stroke (14%) compared to their healthier counterparts. For every 5-unit increase in BMI, individuals were 10% more at risk of stroke.

Furthermore, obesity is associated with dementia, where individuals who were obese in mid-life are at 41% increased risk of dementia. Interestingly, individuals who are underweight in later-life have an increased risk of 17%. Obesity throughout life can also contribute to depressive disorders in women. There was limited evidence on the association between depressive disorders and obesity in childhood and adolescents.

Diet

Consumption of a healthy diet was the second most common protective factor after physical activity, providing protective effects across all NCDs except COPD, and some eye health conditions. Amongst the eye health conditions, high fish and low meat consumption may be protective of AMD. There was limited evidence for the effect of diet on cancer. High fruit intake may be protective of stomach cancer, whereas high salt consumption may increase risks. A high vegetable intake may also provide protective effects for breast cancer. An overall healthy diet with high fruit and vegetable intake may reduce the risk of lung and colorectal cancer as well as depressive disorders. Fish consumption may also reduce the risk of depressive disorders by 20%.

A Mediterranean diet, in particular, has protective effects against NCDs studied. Individuals were reported to be protected against the onset of diabetic retinopathy through consumption of a Mediterranean diet, high consumption of fruit and vegetable, oily fish, polyunsaturated fatty acids, dietary supplements, and fibre. A high adherence to a Mediterranean diet could also reduce an individual’s risk by up to 30% for stroke, coronary heart/artery disease and dementia.

Finally, specific micronutrient intake is associated with the development of eye health conditions and NCDs. Vitamin D was strongly associated with diabetic retinopathy, with low levels of vitamin D reported to increase risk by between 27% and 103%. Lower blood concentration of vitamin D3 may also decrease the risk of myopia by 10%, adjusting for sunlight exposure and time spent outdoors. Low vitamin D levels were also reported to increase an individual’s risk of depressive disorders by 30%, and thereby higher vitamin D levels may be protective against development of depressive disorders. There was limited evidence available to suggest vitamin A and C may reduce risk of diabetic retinopathy.
Diabetes

For every year living with diabetes, individuals have a 9% increased risk of developing diabetic retinopathy. With every increase in fasting blood glucose mmol/L and Hba1c%, there was a 33% and 15% increased risk of diabetic retinopathy respectively. Furthermore, individuals with diabetes have a 48% increased risk of glaucoma. Finally, individuals previously diagnosed with diabetes, but not newly diagnosed diabetes or those experiencing impaired glucose metabolism, were found to be 29% more at risk of depressive disorders. Those with type 2 diabetes also have an increased risk of dementia, with females (68%) reported to have a slightly higher risk than males (61%). Diabetes can also contribute to CVDs, particularly in older adults.

Social determinants

There were no systematic reviews on social determinants and their association with eye health conditions. As such this rapid review did not document the common social determinants of eye health conditions and NCDs. There was however systematic review evidence of social determinants’ influence on NCDs. The level of attained education was the most commonly cited social determinant for NCDs. Compared to higher education levels, lower education levels were associated with increased risk of breast (25%), lung (females, 54%: males, 84%), colon (3%), prostate (60%), stomach (197%), liver (females, 30%; males, 55%), cervical (21%), non-Hodgkin lymphoma (females, 14%; males, 10%), and bladder (females, 37%; males, 15%) cancer. Lower education levels were associated with a high risk of CVDs, ranging from 23% to 50%, COPD (61%), and dementia (81%).

Socioeconomic status (SES) and income earned also influence NCD development. Individuals with a lower SES or lower income earners have an approximate 25% higher risk of breast, stomach, and cervical cancer than those with a higher SES or income. Individuals with a lower SES or income are also more likely to develop CVDs (ranging between 30% and 49%), depression (14%), and have a higher prevalence of COPD than those with a higher SES or income.

Discussion

Eye health conditions and NCDs are going to be increasingly co-prevalent with ageing of the global population, considering that all investigated conditions are more prevalent in older adults. Sex disparities in health were evident too, with females more at risk of diabetic retinopathy, cataract, uncorrected refractive error, CVDs, and depressive disorders, while males were more at risk of glaucoma, cancer, and COPD.

This rapid review provided strong support for smoking cessation to prevent co-morbid eye health conditions and NCDs. Smoking was associated with cancer of the lung, colorectum, stomach, liver, cervix, and bladder, COPD, stroke and coronary heart/artery disease, dementia, and many eye conditions including cataract, age-related macular degeneration, and diabetic retinopathy, with weaker evidence for glaucoma. Public health campaigns to reduce harmful effects of sun exposure are similarly likely to reduce risk of cataract and skin cancer. This review also found poor diet, obesity and low physical activity were common risk factors between NCDs and eye health conditions.

Dietary recommendations specifically derived from this review are more complex. Consumption of vegetables and fruits were protective for some common cancers and depression. The Mediterranean diet was protective against stroke, coronary heart/artery disease and mixed CVD, and also diabetic retinopathy. There was evidence that certain food groups and micronutrients can reduce the risk of depressive disorders but also eye conditions like cataract, diabetic retinopathy, glaucoma, and AMD. However, there was insufficient evidence that dietary supplementation with multivitamins can reduce the risk of cataract, and limited evidence for AMD and diabetic retinopathy. Our evidence synthesis suggests that dietary modification should be considered holistically in conjunction with other risk factors, and ocular and systemic comorbidities.

Physical activity can be protective against a range of general health conditions including CVD and depressive disorders, and there was some protective effect against AMD, diabetic retinopathy, and refractive error. Preventative initiatives which aim to reduce smoking, improve diet, and promote physical activity are thus likely to have the greatest shared benefits for general and eye health. A summary diagram highlighting established common risk factors between eye health conditions and NCDs is shown in Figure 2.
These causal associations can be bidirectional and vision impairment can act as a barrier to accessing health care. Individuals with blindness or vision impairment are less able to access or receive medical care and prescription medicines, and may also delay accessing care, compared to those without vision impairment. Transportation and lack of accommodation were identified as significant barriers to medical care accessibility in those with blindness. In addition, the Million Women Study in the UK showed that women with visual loss were 47% less likely to participate in breast cancer screening and 30% less likely to take part in bowel cancer screening compared to women with no disabilities. Furthermore, functional limitations, which can be a consequence of vision impairment and general health conditions, limit an individual’s ability to travel for health care. In older adults with diabetes, approximately 37% and 29% found it difficult to walk and climb stairs respectively. However, when vision impairment was also present, 53% and 44% found it difficult to perform these activities respectively. This reflects an almost sixfold increase in functional limitations in older adults with comorbid general and eye health conditions compared to their healthy peers. Vision impairment itself also contributes to greater difficulty in walking and climbing stairs. Older people with vision impairment take approximately 26% fewer steps each day, spend 48% less time in moderate or vigorous physical activity and do not travel as far from home as their normally-sighted peers.

Qualitative studies have reported that individuals will prioritise accessing health care for conditions they consider more urgent or time sensitive, over conditions that cause vision impairment. A study based in Cameroon and India, found individuals do not place the same amount of effort into treating eye conditions compared to NCDs, despite access to free vision services, and were often more accepting of vision impairment as they believed it was a normal part of ageing. In order to prevent or reduce the risks of comorbidity, competing health priorities, and inaccessibility of health care, increasing efforts should be placed into merging eye health into NCD risk reduction and prevention programs, especially given that they share common risk factors.

Lower levels of education, lower socio-economic status and lower income earned were associated with increased risks of cancer, CVDs and COPD. Lower education levels was also associated with increased risk of dementia, while lower SES and lower income earned was associated with depressive disorders. This review did not capture evidence about social determinants of eye health conditions as no systematic reviews reporting associations were captured in Ovid Medline between the selected search dates. The association between social determinants of health and eye health warrants further research and attention as several individual studies suggest social determinants influence eye health conditions. For example, myopia is more prevalent in individuals who completed higher levels of education.

Figure 2. Shared risk factors between common eye health conditions that cause vision impairment and non-communicable diseases. Established risk factors are shown in a solid line, established protective factors are shown in a dashed line, and risk factors with conflicting evidence are shown in a dotted and dashed line. CVD, cardiovascular disease; CHD/CAD, coronary heart disease/coronary artery disease; COPD, chronic obstructive pulmonary disorder.
compared to those who completed primary or secondary levels of education. Geographical location can also influence myopia, where the risk of myopia is greater in children from urban areas than those from rural areas.

The inverse is true for cataract blindness, where a higher prevalence is seen in those with lower levels of attained education and those living in rural areas. Increased cataract severity is also seen in individuals with lower levels of SES and lower income earned compared to those of higher levels of SES and higher income earned. Furthermore, disparities in access to care and affordability of health care most often affect individuals of lower SES and income earned. Such individuals are less likely to access cataract treatment or undergo diabetic retinopathy screening compared to their wealthier counterparts. A meta-analysis based on the US population found that irrespective of an individual’s age or diabetes status, lower incomes were associated with decreased utilisation of eye care services. Reducing out-of-pocket costs and service reach to rural communities and those living with disadvantage, were identified as one of the grand challenges in global eye health by the Lancet Commission. This highlights the importance of reducing inequities and disparities experienced by people living with disadvantage as this could lead to risk reductions in eye and general health.

Strengths and limitations

The strength of this rapid review is the use of a pragmatic search strategy which allowed a broad overview of the shared risk factors between common eye health conditions and NCDs. With the inclusion of systematic reviews and overviews of systematic reviews, the most up to date evidence was synthesised. Furthermore, this review extracted risk factors from world-leading research authorities who regularly curate, update and publish global evidence. The GBD series is the largest international epidemiological study, regularly updating evidence on risk factors, morbidity, and mortality of major diseases at a national, regional, and global level. IARC and WCRF are widely respected, international authorities on cancer control and regularly evaluate and publish evidence on the causality of exposures and agents for cancer. This rapid review also had significant strengths in the breadth of expertise of authors, providing a broad overview of the intersection between two major categories of global burdens of disease, enabling more strategic interventions in NCD and eye health prevention programs in future.

Limitations in this rapid review were largely driven by constraints which are intrinsic to rapid reviews. Rapid reviews are resource-limited systematic reviews, used to provide evidence to policy-makers in a timely manner. The accelerated timeline limited title and abstract screening, full-text review, data extraction, and synthesis to one reviewer, introducing potential for reviewer bias. This was exacerbated by the potential for selection bias through searching of one database per condition and studies not being assessed for quality and bias. Further bias was potentially introduced through synthesising studies with different populations, statistical analyses, reporting methods, and low-quality evidence. Only the most prevalent top 10 cancers in 2017 were included in the cancer search, and only COPD was included in the Chronic Respiratory Disease search, as these impact large groups of people.

We identified risk factors shared between eye health conditions and NCDs. While these can contribute to the development of health conditions, the effect of multiple risk factors upon health conditions was not investigated. Rather than multiple independent relationships, there are most likely complex interactions and potential synergistic effects of multiple risk factors, strength of association, and development and severity of disease. Furthermore, comorbidity likely exacerbates certain risk factors, in particular access to health care.

Age is one of the most established risk factors for eye conditions and NCD development. Further exploration into how age contributes to increased risks can help understand its role in the global burden of disease. The role of social determinants in the development of eye health conditions also needs further investigation.

Conclusion

This rapid review provides an overview of the shared risk factors between eye health conditions that can cause vision impairment and NCDs. Given the substantial overlap of risk factors between the investigated conditions, increasing efforts should be made to integrate their respective preventative and risk reduction initiatives to achieve shared benefits in the future.

Data availability

Extended data
This project contains the following extended data:

1. **PRISMA checklist.** The checklist used to report the preferred reporting items for systematic reviews in this rapid review.

2. **Search Strategy.** The search strategy used to identify the risk factors for each eye health condition and noncommunicable disease discussed in this rapid review.

Data are available under the terms of the [Creative Commons Attribution 4.0 International license (CC0-BY 4.0)](https://creativecommons.org/licenses/by-nc-sa/4.0/).

All data collected for the study is held in the below repositories and will be available at the time of publication with the journal.

**Repository:** Supporting Data and Information for “Risk factors common to leading eye health conditions and major non-communicable diseases: a rapid review and commentary”, Dryad Dataset, [https://doi.org/10.5061/dryad.gxd2547q0](https://doi.org/10.5061/dryad.gxd2547q0).

- Data Extraction Tables. Evidence synthesis for risk factors of health condition discussed, where the scientific evidence has been systematically assessed.

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication)](https://creativecommons.org/publicdomain/zero/1.0/).

Tables provided in Extended Data 3

Table 1: Evidence synthesis for eye diseases with overlapping risk factors with non-communicable diseases, where the scientific evidence has been systematically assessed

Table 2: Evidence synthesis for cancer risk factors, where the scientific evidence has been systematically assessed

Table 3: Evidence synthesis for social determinants of cancer, where the scientific evidence has been systematically assessed

Table 4: Evidence synthesis for cardiovascular diseases risk factors, where the scientific evidence has been systematically assessed

Table 5: Evidence synthesis for COPD risk factors, where the scientific evidence has been systematically assessed

Table 6: Results for dementia risk factors, where the scientific evidence has been systematically assessed. Results are displayed as odds ratios, unless otherwise specified.

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**References**


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