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Effects of Smoking on Ocular Health: Structural and Functional Visual Outcomes with Implications for Nursing Practice

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ABSTRACT

Background: Smoking remains a major preventable threat to global public health. While its cardiovascular, respiratory, and oncological effects are well established, its ocular impact receives less attention in clinical and public health settings. ***Purpose*:** To examine the effects of smoking on ocular structures, visual function, and developmental visual outcomes, and to explore the implications for nursing practice and public health. ***Methods*:** A systematic review was conducted in accordance with PRISMA 2020 guidelines. Due to heterogeneity in study designs and outcome measures, findings were synthesized narratively. Epidemiological, clinical, and meta-analytic studies examining the association between smoking and ocular outcomes were systematically identified, screened, and synthesized according to predefined eligibility criteria. ***Results*:** Smoking was consistently associated with age-related macular degeneration, cataract, dry eye disease, inflammatory disorders, retinal vascular disease, and visual impairment. Prenatal exposure was linked to developmental visual abnormalities. Proposed mechanisms include oxidative stress, vascular dysfunction, and inflammation. ***Conclusion*:** Smoking is a modifiable risk factor for vision-threatening conditions, and strengthened cessation strategies and interdisciplinary care may reduce preventable visual impairment. ***Implications for Nursing*:** Understanding smoking-related ocular risks can support nurses in integrating vision-health education into smoking cessation counseling and preventive care strategies.

Keywords: Smoking, Ocular disease, Visual function, Age-related macular degeneration, Nursing practice, Public health.

What does this paper add?

1. It provides an integrated synthesis of evidence linking smoking exposure with structural, functional, and developmental ocular outcomes.
2. It highlights biological mechanisms connecting smoking with retinal, ocular surface, and inflammatory eye diseases.
3. It emphasizes the role of nurses in smoking prevention, patient education, and vision-health promotion.

Introduction

Smoking remains one of the leading preventable causes of morbidity and mortality worldwide (World Health Organization, 2019). Although its cardiovascular, respiratory, and oncological consequences are well established, the ocular effects of smoking remain comparatively under-recognized in both clinical counseling and public health messaging (World Health Organization, 2019). While smoking has been increasingly identified as a risk factor for multiple ocular conditions, existing evidence is dispersed across structural, functional, and developmental domains, limiting its translation into clinical practice and preventive care. Moreover, the implications of smoking-related ocular damage for nursing practice have not been comprehensively synthesized.

Nurses play a critical role in health promotion, smoking cessation counseling, and early identification of individuals at risk of smoking-related visual impairment. Therefore, the aim of this review is to examine the effects of smoking on ocular structures, visual function, and developmental visual outcomes, and to explore the implications for nursing practice and public health.

The retina's high oxygen consumption, metabolic demand, and microvascular dependence make it particularly susceptible to oxidative stress and vascular compromise induced by smoking exposure (Myers et al., 2014; Quiroz-Reyes et al., 2025; Thornton et al., 2005). Recent longitudinal evidence further supports the association between smoking and age-related macular degeneration (AMD) (Myers et al., 2014). Smoking generates reactive oxygen species, reduces antioxidant defenses, and promotes endothelial dysfunction, mechanisms implicated in retinal degeneration, lens opacification, inflammatory ocular disease, and vascular occlusion (Cong et al., 2008; Thornton et al., 2005). Beyond adult-onset disease, prenatal exposure to smoking toxins may disrupt ocular development and visual pathway maturation (Bruin et al., 2010).

Smoking remains highly prevalent in many regions, including the Middle East, underscoring the need to integrate ocular health considerations into smoking prevention strategies (World Health Organization, 2019). This review synthesizes current evidence on the effects of smoking on ocular structures, visual function, and visual development, with particular emphasis on its relevance to preventive eye care and nursing practice. Strengthening awareness of smoking-related ocular risks may support early detection strategies and enhance the effectiveness of smoking cessation interventions.

Methods

Study Design

This study was conducted as a systematic review in accordance with PRISMA 2020 guidelines. Findings were synthesized narratively due to heterogeneity in study designs, populations, and outcome measures. Evidence from epidemiological, clinical, and meta-analytic studies examining the association between smoking and ocular outcomes was systematically identified and synthesized. The review framework predefined exposure variables (active smoking, passive exposure, and prenatal smoking), ocular outcomes, eligible study designs, and quality appraisal procedures. Due to heterogeneity in study designs, populations, and outcome measures, a meta-analysis was not performed, and findings were synthesized narratively.

A structured review protocol was developed prior to literature screening to define the review question, search strategy, eligibility criteria, ocular outcome domains, and data extraction fields; however, the protocol was not prospectively registered. A PRISMA 2020 checklist was completed to support transparent reporting.

Search Strategy

A comprehensive search was performed in PubMed, Scopus, and Web of Science for studies published between January 2000 and February 2025. Google Scholar and manual reference screening were used as supplementary approaches to identify additional relevant papers not captured in the main database search.

Search terms included combinations of: smoking OR smoking exposure; ocular disease OR visual function; age-related macular degeneration; cataract; dry eye; uveitis; diabetic retinopathy; retinal vein occlusion; strabismus; amblyopia; and maternal smoking. Boolean operators (AND/OR) were used to refine searches.

Eligibility Criteria

Inclusion Criteria

- Studies involving human participants
- Observational (cohort, case-control, cross-sectional) studies, clinical comparative studies, and meta-analyses
- Systematic reviews and meta-analyses relevant to the study objectives
- Studies reporting ocular or visual outcomes
- Studies published in English.

Exclusion Criteria

- Animal-only studies
- Case reports
- Editorials or opinion pieces
- Studies without reported ocular or visual outcomes.

Study Selection

A total of 512 records were identified through database searches. After removal of duplicates (n = 84), 428 records remained for title and abstract screening. Seventy-four full-text articles were assessed for eligibility, of which 32 studies met the predefined inclusion criteria and were included in the qualitative synthesis (Figure 1). Because this was a single-author review, formal inter-reviewer disagreement procedures were not applicable. In cases of uncertainty during screening, full-text articles were reassessed against the predefined eligibility criteria before final inclusion decisions were made. Studies cited for contextual background, policy implications, or implementation (e.g., public awareness and cessation messaging) were retained in the narrative discussion, but were not included in the qualitative synthesis or Table 1.

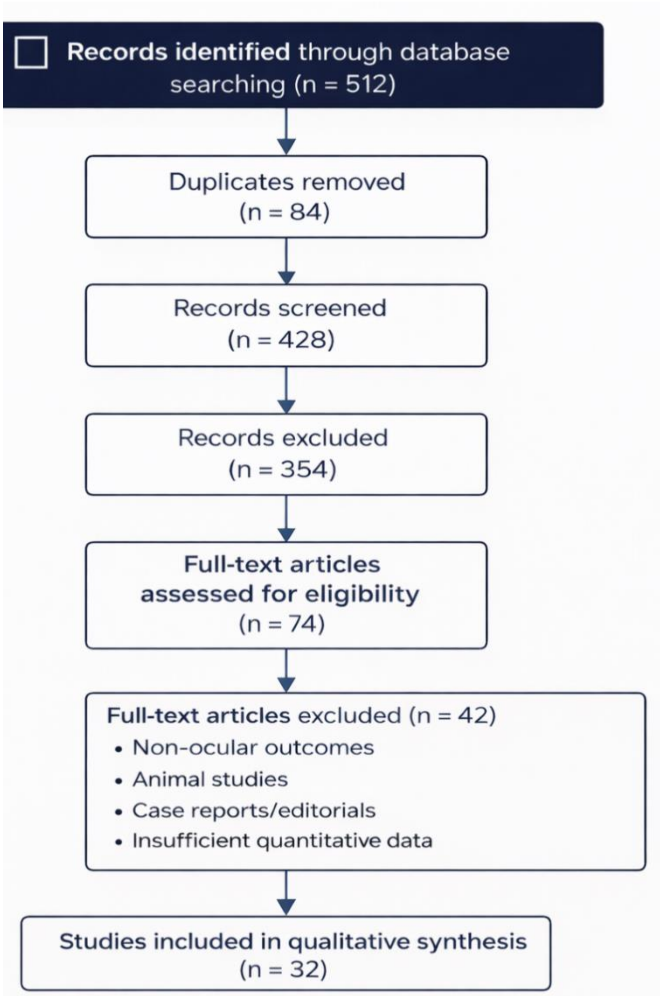

Figure 1. PRISMA flow diagram illustrating the study identification, screening, eligibility assessment, and inclusion process for studies examining the relationship between smoking exposure and ocular disease

Data Extraction

Data was extracted using a standardized data extraction framework developed for this review. Extracted variables included author and year, country/setting, study design, participant characteristics, sample size, smoking exposure definition, ocular outcomes, key clinical or diagnostic methods, statistical approach, and effect estimates (odds ratios [OR], relative risks [RR], and hazard ratios [HR] with 95% confidence intervals), where available. As this was a single-author review, screening, full-text assessment, data extraction, and quality appraisal were conducted by the author using predefined eligibility criteria and a structured extraction framework. To enhance consistency, the process was repeated and cross-checked against the final evidence table and reference list prior to manuscript finalization.

Table 1. Summary of studies included in the qualitative evidence synthesis of smoking-related ocular outcomes (n = 32)

Study (Year)	Country/ Setting	Participants/ Sample Size	Design	Methods (key measures)	Main findings (smoking-related)
Thornton et al. (2005)	International	17 studies	Review	Synthesis of observational AMD studies	Smoking consistently associated with increased AMD risk (2-3-fold increase)
Cong et al. (2008)	International	13 studies	Meta-analysis	Pooled risk estimates	Increased AMD risk (RR ~1.6-1.8)
Khan et al. (2006)	UK	n = 435 cases, 280 controls	Case-control	Smoking exposure (pack-years)	Dose-response relationship for AMD (OR = 2.75)
Myers et al. (2014)	USA	n = 4439	Prospective cohort study	Longitudinal AMD follow-up	Smoking associated with increased incidence and progression of AMD
Kelly et al. (2005)		27 studies	Review	Epidemiologic synthesis with causal criteria	Strong association between smoking and cataract, particularly nuclear cataract (3 fold increase), with dose-response and evidence of reversibility
Christen et al. (2000)	USA	n = 20,907	Prospective cohort study	Cataract incidence	Smoking cessation reduced risk
Ejdervik-Lindblad et al. (2005)	Sweden	n = 34,595	Prospective cohort study	Smoking exposure	Reduced cataract risk after cessation (RR = 0.64)
Ejdervik-Lindblad et al. (2014)	Sweden	n = 44,371	Prospective cohort study	Cataract extraction	Risk decreased with time since quitting ($p < 0.0001$)
Ye et al. (2012)	International	10 studies	Meta-analysis	Pooled cataract risk	Increased cataract risk, particularly nuclear cataract (OR = 1.66)
Bhutia et al. (2021)	India	n = 100	Comparative clinical study	Tear function tests, OCT	Reduced tear function in smokers ($p < 0.0001$)
Xu et al. (2016)	International	10 studies	Meta-analysis	Pooled OR	Smoking associated with increased dry eye risk (OR = 1.50)
Uchino et al. (2016)	Japan	n = 88	Cross-sectional study	Tear function, goblet cells	Reduced tear secretion and mucin ($p < 0.05$)
García-Domene et al. (2022)	Spain	n = 75	Case-control study	Color vision assessment	Impaired color discrimination ($p < 0.001$) and reduced sensitivity ($p = 0.040$)
Fernandes et al. (2017)	Brazil	n = 48	Experimental comparative study	Contrast sensitivity function	Reduced contrast sensitivity ($p < 0.030$)
Díez-Ajenjo et al. (2021)	Spain	n = 28	Comparative clinical study	Color vision assessment	Blue-yellow deficit detected ($p = 0.002$)
Lin et al. (2010)	USA	n = 564 cases, 564 controls	Case-control study	Uveitis diagnosis	Increased uveitis risk (OR = 2.2)
Yuen et al. (2015)	USA	n = 100 cases, 200 controls	Case-control study	Incident uveitis	Increased noninfectious uveitis risk (OR = 2.33)

Thornton et al. (2007)	International	14 studies	Review	Thyroid eye disease (TED) outcomes	Smoking strongly associated with TED (OR 1.22-20.2), with evidence of dose-response effect, increased incidence, and poorer outcomes; reduced risk observed in ex-smokers
Cai et al. (2018)	International	73 studies	Meta-analysis	Pooled RR	increased DR risk in type 1 diabetes (RR = 1.23), but decreased risk in type 2 diabetes (RR = 0.92), indicating heterogeneous associations across diabetes types
Wang et al. (2024)	Multi-cohort	n ≈ 12,000 (combined survey + genetic datasets)	Cross-sectional and Mendelian randomization study	Genetic and survey data	Smoking inversely associated with DR risk (OR = 0.50; $p < 0.05$), supported by cross-sectional and MR analyses; associated with onset, but not progression
Jabbar et al. (2024)	Pakistan	n = 100	Comparative clinical study	Tear tests, OCT RNFL	Reduced tear function ($p \leq 0.02$) and RNFL thinning in smokers ($p < 0.001$), indicating ocular surface and neuroretinal damage
Wimpissinger et al. (2004)	Austria	n = 24	Physiologic comparative study	Choroidal blood-flow assessment	Higher baseline choroidal blood flow in smokers ($p = 0.018$) with impaired vascular reactivity ($p \leq 0.048$), indicating dysregulated ocular blood flow
Zhou et al. (2016)	International	6 studies	Meta-analysis	Pooled glaucoma risk	No significant association between smoking and glaucoma risk (RR = 0.97; $p > 0.05$), with consistent findings across studies
Yee et al. (2024)	International	19 studies	Meta-analysis	Pooled glaucoma data	No significant association between smoking and glaucoma (OR = 0.96)
Quiroz-Reyes et al. (2025)	International	4 studies (702 eyes)	Meta-analysis	OCT parameters (choroidal vascularity index, retinal and choroidal thickness)	Smoking reduced choroidal vascularity (SMD −0.61; $p < 0.00001$), with no significant effect on retinal thickness
Ben Salah et al. (2024)	Tunisia	n = 57 cases, 105 controls	Case-control study	RVO risk factors	Smoking identified as RVO risk factor
Kolar (2014)	International	68 studies	Review	Mechanism synthesis	Smoking linked to vascular risk
Yang et al. (2019)	International	11 studies	Meta-analysis	Strabismus outcomes	Maternal smoking increased risk of offspring strabismus (OR = 1.46), with dose-response effect (OR = 1.79)
Li et al. (2016)	International	9 studies	Meta-analysis	Refractive error/amblyopia outcomes	Maternal smoking associated with increased risk of amblyopia (OR = 1.47) and hyperopia (OR = 1.43) in offspring of smoking mothers
Altinors et al. (2006)	Turkey	n = 60 cases, 34 controls	Comparative clinical study	Tear function	Reduced tear film stability in smokers (TBUT 5.3 s), with increased lipid layer abnormalities
Stone et al. (2006)	USA	n = 323	Prospective cohort study	Refraction outcomes	Smoking exposure affected refractive development with lower myopia prevalence ($p = 0.004$) and more hyperopic refraction ($p = 0.02$) in children
Zhang et al. (2023)	International	n = 12630	Cross-sectional study	Myopia outcomes	Increased myopia risk and progression (OR = 2.64)

* This table includes studies meeting the predefined inclusion criteria for qualitative synthesis (n=32). Additional references cited in the text were not included in this table. (OR: Odds ratio, RR: Risk Ratio, RNFL: Retinal Nerve Fiber Layer, SMD: Standardized Mean Difference, OCT: Optical Coherence Tomography, TED: Thyroid eye disease, RVO: Retinal Vein Occlusion, TBUT: Tear Break Up Time).

Quality Assessment

Cohort and case-control studies were evaluated using the Newcastle-Ottawa Scale. Meta-analyses were assessed using AMSTAR-2. Risk of bias considerations included confounding, exposure misclassification (self-report), and publication bias.

Statistical Approach

No new inferential analyses were performed by the author. Instead, statistical procedures reported in the included studies were extracted and summarized. Because of heterogeneity in study designs, exposure definitions, and outcome measurements across the included studies, a quantitative meta-analysis was not conducted. Instead, findings were synthesized narratively to provide an integrated overview of the available evidence. Across the included evidence base, the most frequently reported statistical approaches included:

- Logistic regression (reporting ORs) for binary outcomes, such as AMD presence, uveitis, or strabismus (Khan et al., 2006; Lin et al., 2010).
- Cox proportional hazards models (reporting HRs) for time-to-event outcomes, such as cataract extraction (Ejdervik-Lindblad et al., 2005; Ejdervik-Lindblad et al., 2014).
- Linear regression and group comparison tests (e.g., t-tests/ANOVA) for continuous outcomes, such as tear tests, contrast sensitivity, and OCT parameters (Bhutia et al., 2021; Fernandes et al., 2017; Uchino et al., 2016).
- Meta-analyses commonly used fixed- or random-effects models and assessed heterogeneity using I^2 (Cai et al., 2018; Cong et al., 2008; Ye et al., 2012).

Due to heterogeneity in exposure definitions, study populations, and ocular outcomes, findings were synthesized narratively rather than pooled in an additional meta-analysis. The objective of this review was to provide an integrative narrative synthesis of the evidence rather than perform an additional quantitative pooled meta-analysis.

Ethical Approval

Ethical approval was not required for this study, because it is based exclusively on analysis of previously published literature.

Compliance with Ethical Standards

The manuscript was prepared in accordance with COPE principles; sources are cited and findings are presented to reflect the original evidence accurately.

Informed Consent

Not applicable.

Step-by-Step Review Process

The review process was conducted in five sequential stages. First, a structured database search was performed in PubMed, Scopus, and Web of Science, with Google Scholar and manual reference list screening used as supplementary approaches. Second, duplicate records were removed and titles and abstracts were screened against the predefined eligibility criteria. Third, full-text articles were assessed for inclusion. Fourth, data was extracted using a standardized data extraction framework. Fifth, the included studies were appraised according to study design and synthesized narratively across major ocular domains. This stepwise approach was adopted to ensure transparency, reproducibility, and consistency in study selection and interpretation.

Results

A total of 32 studies met the predefined eligibility criteria and were included in the qualitative synthesis. These comprised observational studies, clinical comparative studies, and meta-analyses across multiple ocular disease domains, including degenerative retinal disease, cataract, ocular surface disease, inflammatory ocular disorders, retinal vascular disease, visual function impairment, and developmental outcomes.

A structured summary of the included studies is presented in Table 1 to facilitate comparison of study design, sample characteristics, methods, and main findings across ocular domains. Additional studies cited for contextual background were retained in the narrative discussion, but were not included in Table 1.

The methodological quality of included studies varied, with meta-analyses and cohort studies generally providing higher levels of evidence compared with cross-sectional and clinical comparative studies.

Age-Related Macular Degeneration (AMD)

Smoking was consistently identified as a major modifiable risk factor for AMD. Meta-analytic evidence demonstrated increased risk, with pooled estimates approximately in the range of 1.6-1.8 and higher risk among current compared with former smokers (Cong et al., 2008). A clear dose-response relationship based on cumulative pack-years further supports this association (Khan et al., 2006). Longitudinal cohort data also confirm increased incidence and progression of both early and late AMD among smokers (Myers et al., 2014).

Overall, evidence for AMD is strong and consistent across cohort studies and meta-analyses, with minimal conflicting findings.

Cataract

Smoking was strongly associated with age-related cataract. Evidence from epidemiologic reviews indicates a strong and consistent association between smoking and cataract, particularly nuclear cataract, with approximately threefold increased risk and clear dose-response relationships (Kelly et al., 2005). Population-based studies further demonstrated a dose-response relationship between smoking intensity and cataract extraction (Ejdervik-Lindblad et al., 2005).

Smoking cessation was associated with gradual reduction in cataract risk, although residual risk remained due to cumulative exposure (Christen et al., 2000; Ejdervik-Lindblad et al., 2014). Meta-analytic evidence confirmed a stronger association with nuclear cataract (Ye et al., 2012).

The evidence base for cataract is robust and highly consistent.

Ocular Surface Disease and Dry Eye

Smoking exposure was associated with impaired tear-film function and ocular surface instability. Clinical studies demonstrated reduced tear break-up time and lower Schirmer test values among smokers (Bhutia et al., 2021; Jabbar et al., 2024; Uchino et al., 2016). Additional evidence indicated damage to the tear-film lipid layer (Altinors et al., 2006).

Meta-analysis reported a modest, but statistically significant, association between smoking and dry eye disease, with adjusted odds ratios of approximately 1.50 in general-population samples (Xu et al., 2016).

Although findings are generally consistent, this domain relies primarily on observational and clinical comparative studies, with some variability in measurement methods.

Inflammatory Ocular Diseases

Smoking was associated with increased risk of inflammatory ocular conditions. Case-control and population-based studies reported approximately twofold increased odds of uveitis, particularly for intermediate and pan-uveitis subtypes (Lin et al., 2010; Yuen et al., 2015). Smoking was also identified as a major risk factor for thyroid eye disease (TED), increasing disease severity and reducing treatment response (Thornton et al., 2007).

The evidence in this domain is moderately consistent, but largely derived from observational designs.

Retinal Vascular Disease

Smoking contributes to vascular dysfunction and is recognized as a risk factor in retinal vascular disease. Case-control and meta-analytic evidence identified smoking as a contributing factor in retinal vein occlusion risk frameworks (Ben Salah et al., 2024; Quiroz-Reyes et al., 2025), supported by mechanistic evidence summarized in vascular risk literature (Kolar, 2014).

Physiological studies also demonstrated impaired choroidal vascular reactivity among smokers (Wimpissinger et al., 2004). Smoking contributes to impaired ocular blood flow, which may increase the risk of retinal vascular disorders (Kolar, 2014; Quiroz-Reyes et al., 2025).

However, evidence across vascular outcomes is less consistent compared with degenerative diseases, reflecting heterogeneity in study design and outcome definitions.

Visual Function Impairment

Smoking-related functional visual deficits were observed even in the absence of clinically detectable structural disease. Experimental studies demonstrated reduced contrast sensitivity among smokers (Fernandes et al., 2017), while other studies reported impairments in chromatic and blue-yellow color discrimination (Díez-Ajenjo et al., 2021; García-Domene et al., 2022).

These findings suggest that functional impairment may precede structural ocular changes, although evidence is primarily based on smaller experimental studies.

Congenital and Developmental Outcomes

Prenatal smoking exposure was associated with adverse visual developmental outcomes. Meta-analytic evidence demonstrated increased risk of strabismus (Yang et al., 2019) and associations with amblyopia and hyperopic refractive error (Li et al., 2016).

Experimental and epidemiologic studies further suggested disruption of retinal development and visual pathway maturation (Bruin et al., 2010), while early-life exposure to smoking may influence refractive development during childhood (Stone et al., 2006).

The evidence in this domain is moderate and largely observational, with emerging support from epidemiologic studies.

Overall Strength and Consistency of Evidence

The strength of evidence varied across domains. Associations for AMD and cataract were supported by the most consistent findings across cohort studies and meta-analyses. Evidence for dry eye disease and uveitis was moderately consistent, but relied more heavily on observational and clinical comparative designs.

Findings for diabetic retinopathy were heterogeneous, indicating domain-specific variability rather than a uniform smoking effect (Cai et al., 2018; Wang et al., 2024). Evidence for developmental outcomes was moderate and derived primarily from observational studies and meta-analyses. These findings demonstrate conflicting associations across diabetes types and study designs.

Discussion and Implications

Discussion

Smoking affects ocular health through interconnected oxidative, inflammatory, and vascular mechanisms. Smoking-related ocular damage is mediated by oxidative stress, mitochondrial dysfunction, and vascular endothelial injury, leading to impaired retinal perfusion and tissue hypoxia (Cong et al., 2008; Thornton et al., 2005). Degenerative conditions, such as age-related macular degeneration (AMD) and cataract, demonstrate the most consistent and robust associations across observational and meta-analytic evidence (Cong et al., 2008; Kelly et al., 2005; Thornton et al., 2005; Ye et al., 2012).

Importantly, smoking-related functional impairments—such as reduced contrast sensitivity and altered color discrimination—may occur even in the absence of clinically detectable structural disease (Fernandes et al., 2017; García-Domene et al., 2022). This suggests that functional deficits may represent early manifestations of smoking-related ocular toxicity and highlights a potential window for early clinical detection and intervention.

Beyond degenerative changes, the evidence supports inflammatory and immune-mediated pathways. Associations with uveitis and thyroid eye disease indicate that smoking contributes to ocular immune dysregulation and poorer clinical outcomes (Lin et al., 2010; Thornton et al., 2007; Yuen et al., 2015). Vascular mechanisms are further supported by findings related to retinal vein occlusion and impaired choroidal blood-flow reactivity, consistent with endothelial dysfunction and pro-thrombotic effects of smoking (Kolar, 2014; Wimpissinger et al., 2004).

A key strength of this review is its lifespan perspective, incorporating prenatal and developmental evidence. Maternal smoking is associated with increased risk of offspring strabismus and amblyopia, reinforcing the importance of maternal smoking cessation interventions and early pediatric screening (Li et al., 2016; Yang et al., 2019). Notably, smoking-related ocular damage is largely preventable, and smoking cessation has been shown to reduce disease progression risk, particularly in cataract and AMD (Ejdervik-Lindblad et al., 2005), highlighting its clinical relevance as a modifiable risk factor. Smoking cessation may partially restore vascular and ocular surface function over time, further supporting the importance of early preventive intervention and cessation counseling.

However, the strength of evidence varies across ocular domains. While associations for AMD and cataract are strong and consistent, findings for diabetic retinopathy remain heterogeneous across study designs and populations, suggesting the influence of confounding factors and disease-specific mechanisms (Cai et al., 2018; Wang et al., 2024). Similarly, evidence for dry eye disease and inflammatory conditions is moderately consistent, but relies predominantly on observational and clinical comparative studies. These variations underscore the need for cautious interpretation and highlight differences in evidence strength across outcomes.

Strengths and Limitations

This review synthesized evidence across degenerative, inflammatory, vascular, functional, and developmental ocular outcomes, providing an integrated perspective relevant to nursing practice and public health. The use of PRISMA 2020 search and reporting guidelines enhanced transparency in study identification, screening, and selection.

Nevertheless, several limitations should be considered. The available evidence was heterogeneous with respect to smoking exposure definitions (e.g., current versus former smoking, pack-years, and prenatal exposure) and outcome assessment methods, which limited the feasibility of conducting a pooled meta-analysis. Many studies relied on self-reported smoking status, introducing the potential for exposure misclassification. In addition, residual confounding cannot be entirely excluded despite statistical adjustments reported in individual studies. Finally, publication bias remains possible, particularly as studies with null findings may be underreported.

Level of Evidence

Overall, evidence linking smoking to age-related macular degeneration (AMD) and cataract is moderate to high, supported by prospective cohort studies and meta-analyses (Cong et al., 2008; Kelly et al., 2005; Ye et al., 2012). Evidence for uveitis and thyroid eye disease is moderate, based on case-control and systematic review data (Lin et al., 2010; Thornton et al., 2007; Yuen et al., 2015). Evidence for diabetic retinopathy is moderate, but heterogeneous, varying according to diabetes type and study methodology (Cai et al., 2018; Wang et al., 2024). Evidence for congenital and developmental outcomes is also moderate and is derived primarily from observational studies and meta-analyses (Li et al., 2016; Yang et al., 2019).

Across domains, smoking-related ocular damage appears to arise through interconnected biological pathways rather than isolated disease mechanisms. Oxidative stress induced by smoking exposure contributes to vascular dysregulation, ocular surface inflammation, and immune-mediated processes affecting multiple ocular tissues. Smoking-induced vascular dysregulation and chronic inflammation may impair retinal microcirculation and ocular surface homeostasis, contributing to both structural and functional visual abnormalities. These mechanisms provide a biological basis for the diverse retinal, ocular surface, and inflammatory conditions observed in smokers (Figure 2).

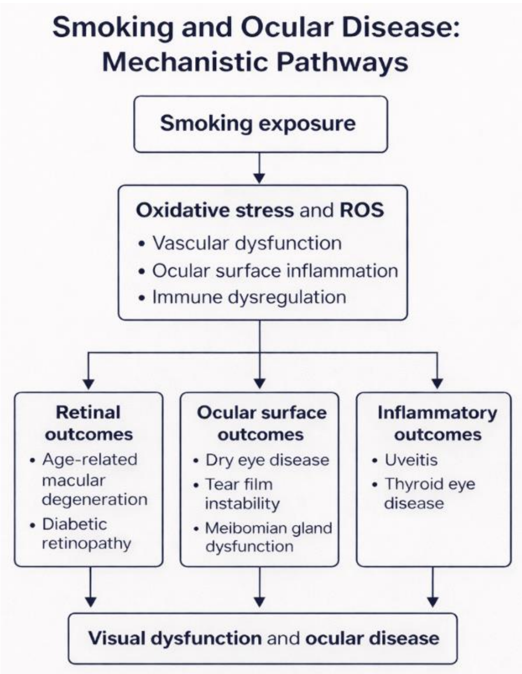

Figure 2. Proposed mechanisms linking smoking exposure to ocular disease

Smoking-induced oxidative stress and reactive oxygen species (ROS) may promote vascular dysfunction, ocular surface inflammation, and immune dysregulation, contributing to retinal disorders (e.g., age-related macular degeneration and diabetic retinopathy), ocular surface disease (e.g., dry eye), and inflammatory ocular conditions. The conceptual model is derived from evidence reported in, Altinors et al., 2006, Cong et al., 2008, Thornton et al., 2005, Wimpissinger et al., 2004 and Xu et al., 2016

The strength of evidence varies across outcomes. Associations for AMD and cataract are the most consistent and are supported by robust cohort and meta-analytic evidence. In contrast, evidence for dry eye disease and uveitis is moderately consistent, but relies predominantly on observational and clinical comparative studies. Findings for diabetic retinopathy remain mixed, reflecting domain-specific heterogeneity rather than a uniform smoking effect.

From a clinical and public health perspective, these findings reinforce the importance of smoking cessation as a key modifiable risk factor for reducing visual impairment and preserving ocular health.

Future Research

Future research should prioritize longitudinal cohort studies with standardized definitions of smoking exposure, objective verification methods, and consistent ocular outcome measures to strengthen causal inference and comparability across studies.

In addition, further investigation is needed into the reversibility of early functional visual deficits following smoking cessation, particularly in relation to contrast sensitivity and tear-film stability.

From an implementation perspective, future studies should evaluate the effectiveness of integrating vision-related risk messaging into smoking cessation programs, maternal health services, and chronic disease care pathways, as well as its impact on behavioral change and clinical outcomes.

Implications for Nursing

Nurses play a central role in smoking cessation counseling, early identification of individuals at risk of visual impairment, and reinforcement of timely referral for eye examination. Integrating ocular health education into routine clinical practice can enhance preventive strategies and support early detection of smoking-related visual dysfunction. Evidence from Jordanian nursing research highlights the importance of targeted educational interventions in addressing smoking behaviors and attitudes among young adults, emphasizing the role of nurses in health promotion and smoking prevention strategies (Alzayyat et al., 2025).

Public awareness of smoking-related blindness remains lower than awareness of cardiopulmonary risks; however, vision-related messaging has been shown to increase smoking cessation intentions (Byrne et al., 2018; Hammond et al., 2006; Sillero-Rejon et al., 2022; Skurka et al., 2018). Nurses are therefore well positioned to incorporate ocular risk communication into smoking cessation interventions across primary care, maternal health, and community settings.

In clinical practice, recommended nursing actions include routine assessment and documentation of smoking status; patient education on ocular risks, such as age-related macular degeneration (AMD), cataract, and ocular surface disease (Cong et al., 2008; Thornton et al., 2005; Ye et al., 2012); targeted counseling for pregnant women regarding fetal visual risks (Bruin et al., 2010; Li et al., 2016; Yang et al., 2019); and referral pathways for comprehensive eye examination and early detection of functional deficits (Fernandes et al., 2017; García-Domene et al., 2022).

Smoking cessation remains the primary modifiable intervention for reducing smoking-related ocular morbidity. Nurses can contribute to early detection by recognizing visual symptoms, reinforcing timely referral for ophthalmic evaluation, and supporting management of ocular surface and vascular risk factors through preventive counseling and interdisciplinary care (Hammond et al., 2006; Jibril et al., 2025).

Interdisciplinary collaboration is essential to strengthen prevention and early intervention. Optometrists and ophthalmologists can detect early functional changes, including reduced contrast sensitivity, altered color discrimination, and ocular surface abnormalities, which may serve as a “teachable moment” to reinforce smoking cessation counseling (Fernandes et al., 2017; Uchino et al., 2016). Coordinated nurse-optometrist referral pathways and joint participation in public awareness campaigns may further enhance prevention efforts across the lifespan (Hammond et al., 2006). Integrating ocular-risk messaging into smoking cessation initiatives may improve public awareness of smoking-related visual impairment and strengthen preventive behavioral change. Consistent with the current findings, nursing research published in the Jordan Journal of Nursing Research reported that nurse-led eye health education interventions significantly improved eye-health awareness, preventive behaviors, and willingness to access eye care services in community settings (Jibril et al., 2025).

Conclusion

Smoking adversely affects ocular structure, visual function, and visual development across the lifespan, with the strongest and most consistent evidence observed for age-related macular degeneration and cataract. These findings identify smoking as a major modifiable risk factor for visual impairment.

Translating this evidence into practice requires targeted, actionable strategies, including routine assessment of smoking status, integration of ocular risk education into clinical and nursing practice, maternal smoking prevention, and structured referral pathways to eye care services for early detection and intervention.

Interdisciplinary collaboration between nursing professionals and eye care providers is essential to strengthen prevention, early identification, and patient education. At a population level, incorporating vision-related risk messaging into smoking cessation programs may further enhance behavioral change and public awareness.

Future research should focus on quantifying reversible visual outcomes associated with smoking cessation and evaluating the effectiveness of vision-based interventions in clinical and public health settings.

Data Availability

All data presented in this study is derived from previously published articles and is available in the public domain through the respective journals and databases.

Conflict of Interests

The author declares no conflict of interests related to this work.

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