

Ocular Changes During Pregnancy and Postpartum: A Narrative Review of Physiological Adaptations and Pathological Conditions

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Abstract

Pregnancy causes major hormonal, vascular, metabolic, and fluid changes that can affect the eye. Some of the physiological and transient changes occurring in the eyes may be associated with pregnancy-induced or pre-existing ocular disorders. Changes may occur in the ocular surface, cornea, refractive status, intraocular pressure, retina, choroid, and optic nerve. Some of these changes become more apparent in the later stages of pregnancy and improve gradually after delivery. However, visual symptoms related to pregnancy should not always be considered normal, as they may be a sign of pre-eclampsia, diabetic retinopathy, central serous chorioretinopathy, retinal vascular abnormalities or neuro-ophthalmic problems. The postpartum period is critical because some pathological problems may persist or become clinically apparent after delivery, and ocular changes may take some time to return to pre-pregnancy form. Therefore, identifying abnormal ocular findings early supports adequate maternal care and helps prevent vision-threatening problems. This review outlines the major physiological and pathological ocular changes during pregnancy and the postpartum period, emphasizing changes in the anterior and posterior segments, pregnancy-related ocular diseases, and neuro-ophthalmic manifestations. The review also highlighted the therapeutic relevance of differentiating ocular symptoms that need urgent evaluation and treatment from normal pregnancy-related changes.

Keywords: Pregnancy, Postpartum, Ocular changes, Vision, Refractive changes, Corneal changes, IOP, Retinal changes.

How to cite this article: Tridip Puzari 1 Haziel Rynjah 2 Rojita Athokpam 3 Puyam Prince Devi 4 Kangjam Yaisana 5 Lipika Sonowal 6. Ocular Changes During Pregnancy and Postpartum: A Narrative Review of Physiological Adaptations and Pathological Conditions. *Int J Drug Deliv Technol*. 2026;16(87s):148-156. DOI: 10.25258/ijddt.16.87s.15.

Introduction

Pregnancy is a unique physiological condition in which the endocrine, cardiovascular, metabolic, immunological and hematological systems experience significant changes. These alterations are crucial for fetal growth and maternal adaptation, though they may also have an impact on the visual system, considering that the ocular tissues are prone to changes in fluid balance, hormonal fluctuation and vascular functions. [1] As a consequence, pregnancy can result in a broad spectrum, from mild reversible physiological changes to possibly severe neuro-ophthalmic and ocular disorders. [2]

Most of the ocular structures, including the eyelids and adnexa, ocular surface, tear film, cornea, crystalline lens, refractive status, Intraocular pressure (IOP), retina, choroid, and optic nerve, might be impacted by pregnancy-related changes. [3,4] A variety of physiological changes become increasingly noticeable during the second and third trimesters and progressively decrease after birth. The duration and severity of these changes may vary during gestation. [5]

Gestational effects on the eyes may be classified into two categories which are pathogenic abnormalities that may develop during pregnancy and physiological changes that occur as a part of normal gestation. In addition, pregnancy may develop ocular signs resulting from pregnancy-related

systemic disorders or altering pre-existing ocular disorders. Additionally, during labour, delivery, or the postpartum period, certain ocular and neuro-ophthalmic complications might develop. [6] After labour and delivery, most of the physiological changes are temporary and ultimately go away, though some might last and require a proper clinical assessment. Pregnancy-related changes in corneal hydration and curvature, tear-film stability, meibomian gland function, and other anterior segment parameters may result in blurred vision, shift in refractive error, alterations to accommodation, contact lens sensitivity, ocular dryness, and discomfort. Moreover, changes in curvature and thickness in the cornea may result in intermittent refractive fluctuations, which makes the refractive assessment during pregnancy significantly different from that in the non-pregnant condition. [3,4]

Visual concerns during pregnancy, however, are not considered normal. Ocular symptoms can often be a sign of severe ocular and systemic diseases. Retinal changes, serous retinal detachment, and cortical visual alterations can develop from hypertensive diseases of pregnancy, including pre-eclampsia and eclampsia. Furthermore, diabetic retinopathy, central serous chorioretinopathy, inflammatory ocular disorders, glaucoma, thyroid-associated eye

disease, and intracranial hypertension may all be impacted by pregnancy. Retinal vascular occlusions, optic neuropathies, cerebral venous sinus thrombosis, and other neuro-ophthalmic conditions are less common but possibly a blinding outcome. [7]

Considering that ocular healing rarely occurs right away after the delivery, the postpartum interval is equally significant. Although some pathological abnormalities may remain or infrequently become more clinically observable after childbirth, and other physiological ocular parameters are restored to their pre-pregnancy condition. [5]

This narrative review compiled the available evidence on physiological and pathological ocular changes occurring during pregnancy and the postpartum period. The postpartum alterations involving the ocular surface, cornea, refractive status, intraocular pressure, retina, and choroid, as well as pregnancy-associated ocular diseases, neuro-ophthalmic symptoms and ocular concerns during labour and after delivery.

Hormonal and systemic basis of ocular changes during pregnancy

During pregnancy, there is a significant rise in estrogen and progesterone levels, especially during the second and third trimester. These hormones alteration are not just restricted to the reproductive system but also impact the visual system because sex steroid receptors and hormone-responsive pathways are found in several ocular tissues including the cornea, conjunctiva, lacrimal glands, and meibomian glands. Consequently, hormones changes may affect tear film homeostasis, corneal hydration, ocular surface function and vascular regulation. [8,9]

In addition to endocrine alteration, pregnancy also leads to increased plasma volume, reduced systemic vascular resistance, fluid retention and changes in immune function. These changes may influence aqueous humor dynamics, corneal thickness, retinal circulation, and choroidal perfusion. Therefore, the ocular manifestation of pregnancy should be considered the result of complex interaction between hormonal, vascular, metabolic, and fluid-related mechanisms rather than just one single physiological pathway. [6]

Physiological Ocular Changes During Pregnancy

During pregnancy, the eye may undergo both anatomical and functional changes.

Eyelid and Adnexa

During pregnancy pigmentary changes may occur involving the face and preorbital region as a result of increase in hormonal stimulation of melanogenesis melasma /chloasma also known as “the mask of pregnancy”, is a physiological pigmentary change caused by increased hormonal stimulation of melanogenesis during pregnancy. [1] It usually develops in the 2nd trimester of pregnancy and occurs in about 75% of pregnant women, mainly

affecting the facial skin and sometimes the eyelids and preorbital region. Increased melanocyte-stimulating activity, along with estrogen and progesterone, contributes to the increased pigmentation. Melasma generally fades gradually after delivery about 90% of women show regression within 12 months postpartum. Pregnancy may also cause mild eyelid edema due to fluid retention and, rarely, temporary ptosis. Most of the changes are physiological and resolve spontaneously during the postpartum period. [5]

Table 1. Summary of physiological and pathological ocular changes during pregnancy and the postpartum period.

Ocular system	Major changes during pregnancy	Typical timing during pregnancy	Postpartum/clinical significance
Ocular surface	Dry eye symptoms, alteration in tear film stability and contact lens intolerance	Throughout pregnancy	Usually improves after delivery.
Cornea and refraction	Increases corneal thickness or hydration, altered curvature and transient refractive fluctuation	Mainly during second and third trimesters.	Generally reversible, defer permanent refractive changes until stability

Intraocular pressure	Physiological reduction in IOP	During second and third trimesters	Returns toward non-pregnant levels postpartum
Retina and choroid	Changes in retinal microcirculation and increased choroidal thickness.	During gestation periods	Gradual vascular and choroidal recovery after delivery
Pregnancy-related pathological changes	Pre-eclampsia, CSCR and progression of diabetic retinopathy may cause significant visual symptoms	Depends on underlying conditions	Requires timely ophthalmic and systemic assessment
Neuro-ophthalmic and post-partum concerns	IIH, papilledema and other neuro-ophthalmic symptoms may occur, labour-related hemorrhage is uncommon	Pregnancy, labour and puerperium	Persistent or sudden visual symptoms require urgent evaluation

Ocular surface and dry eye changes

During pregnancy, the ocular surface is influenced by pregnancy-related hormonal changes because of estrogen, progesterone, and androgens, which can impact the surface of the eye. These hormonal pathways may affect tear film stability and the meibomian gland secretion, resulting in ocular dryness, burning, foreign body sensation, fluctuating vision, and contact lens intolerance. [1]

A recent clinical study has shown changes in dry eye parameters and meibomian gland function during pregnancy, which confirmed that pregnancy does affect the ocular surface. [10] These changes occur through gestation, although symptoms can become noticeable clinically as hormonal and systemic changes progress.

In early pregnancy, dehydration associated with nausea and vomiting may aggravate ocular surface discomfort in susceptible individuals. Persistent or severe dry eye symptoms should be evaluated for underlying ocular surface disease rather than considering the physiological consequence of pregnancy solely. [10]

Corneal Changes

The cornea undergoes measurable physiological changes during pregnancy, especially in the second and third trimesters.

A systematic review and meta-analysis demonstrate that CCT increase notably during the second trimester of pregnancy, with an average rise of about 10.12 µm compared to non-pregnant women. In the third trimester, the thickness tends to keep increasing, although this change was not statistically significant in the results. [11]

Recent evidence has highlighted changes in corneal parameters throughout pregnancy. In a study of women during all three trimesters and three months postpartum, both CCT and thinnest corneal thickness increased. These measurements significantly decreased after giving birth, indicating that pregnancy-related corneal thickness is reversible. [12]

Transient fluctuation in vision and contact lens discomfort may occur due to changes in corneal curvature and hydration. During pregnancy, especially in later stages, corneal sensitivity can decrease but typically improves after delivery. [3,6] Because corneal parameters can be unstable during pregnancy and the early postpartum period, permanent refractive corrections and elective corneal procedure until ocular measurement stabilized.

Pregnancy may influence corneal biomechanics in women with pre-existing corneal ectatic disorder. While the evidence remains limited, hormonal and biomedical changes may also contribute to the progression of keratoconus in susceptible individuals, and highlight the importance of monitoring patients with known corneal ectasia during pregnancy.

Refractive Changes and Visual Acuity

Transient refractive changes are among the most frequently reported visual changes during pregnancy. These changes result primarily from alterations in corneal hydration and curvature. The changes might also involve the crystalline lens, and overall ocular fluid balance may also contribute.

Several studies have noted a gradual myopic shift during pregnancy, in the third trimester of gestation. However, not everyone experiences these changes, and their extent can vary greatly. Some women see significant vision fluctuations, while others have minimal or no changes. [7]

Recent evidence has compared measurements across all trimesters, and the postpartum period has found no statistically significant changes in spherical equivalent in refraction or visual acuity despite significant alteration in anterior segment parameters. [12] Therefore, they should cautiously interpret pregnancy-related refraction and should understand that not all pregnant women develop a clinically significant refractive shift.

The clinical relevance of this finding is important, as a spectacle prescription obtained during pregnancy may not represent the patient's stable refractive status after delivery. Unless visual symptoms significantly interfere with daily activities, permanent changes in refractive correction may be delayed until the postpartum ocular parameters have stabilized. [5]

Accommodation and Binocular Function

Temporary changes in accommodation, including accommodative insufficiency and subjective near-vision difficulties, may be associated with pregnancy and lactation. Hormonal shifts and changes in crystalline lens or fluctuations have been proposed as possible contributing mechanisms. [3] However, the studies regarding accommodative and binocular changes remain inconsistent. Some studies have reported subjective visual discomfort despite minimal changes in objective measures such as near point of accommodation and near point of convergence. Therefore, to clarify the clinical significance and temporal pattern of pregnancy-related accommodative changes, further studies are required. [7]

Intraocular pressure

During pregnancy, the most consistently reported ocular change is physiological reduction in IOP. The reduction becomes more evident as pregnancy progresses and is generally most pronounced during the second and third trimesters. [13]

A systematic review and meta-analysis have reported a significant reduction of approximately 1.53 mmHg during the second trimester and 2.91 mmHg during the third trimester compared with non-pregnant women. [11] These studies suggest a progressive reduction in IOP as gestation progresses. Pregnancy-related changes in corneal thickness and biomechanics may also influence tonometry

measurements, and this should be considered when interpreting IOP values during pregnancy. [6,11]

Recent evidence has similarly demonstrated a significant reduction in IOP towards the third trimester, followed by an increase during the postpartum period. [12] Pregnancy-associated IOP reduction is largely physiological and reversible is interpreted with the support of this pattern.

The decrease in IOP may appear beneficial in women with glaucoma or ocular hypertension; however, during pregnancy glaucoma management may require individualized assessment because IOP should not be considered independently of optic nerve status, visual field, disease severity and medication safety.

Posterior Segment Changes

Retinal and Macular Changes

Pregnancy-induced cardiovascular and hemodynamic changes can affect retinal circulation and microvascular function. Advances in optical coherence tomography (OCT) and OCT angiography (OCTA) have made it possible to detect subtle retinal changes that are not visible during conventional fundus examination. [14]

Studies of healthy pregnant women have reported variation in retinal vascular density and microcirculation, although results vary due to differences in gestational weeks, imaging protocols, and study population. These findings suggest that the retinal circulation reflects systemic vascular adaptation during pregnancy. [15]

Retinal vascular changes may differ during gestation and after delivery. OCTA studies reveal pregnancy-related changes in retinal vascular perfusion, while postpartum imaging shows relative retinal vasoconstriction compared to pregnancy, indicating that retinal vascular adaptation may continue beyond delivery. [16] Though many retinal microvascular changes in uncomplicated pregnancy seem subclinical, pathological visual symptoms should be evaluated, as retinal findings may indicate manifestations of systemic disease.

Choroidal Changes

The choroid, a highly vascularized ocular tissue, is responsive to changes in systemic circulation, vascular permeability, and hormonal regulation. Enhanced depth imaging OCT studies have shown measurable changes in choroidal thickness during pregnancy. [17]

A recent review of 26 studies involving 1,935 women revealed that healthy pregnant women had a thicker sub foveal choroidal of about 31.1µm compared to non-pregnant women. Importantly, no significant differences were found between trimesters, indicating choroidal thickening may occur without major changes across trimesters. The postpartum period shows a clearer reversal of this physiological adaptation with a reduction of about 41.9µm from the third trimester to postpartum,

indicating that pregnancy-associated choroidal thickening is temporary. [18]

These findings support increased choroidal perfusion and vascular adaptation during pregnancy. Understanding physiological choroidal changes is clinically significant, as choroidal dysfunction is linked to pregnancy-associated disorders such as central serous chorioretinopathy and hypertensive retinopathy. [19]

Pathological Ocular Changes Associated with Pregnancy

Few pathological eye abnormalities are particularly associated with a woman's pregnancy.

Pre-eclampsia and Eclampsia

Pre-eclampsia and eclampsia are significant systemic disorders that may affect the visual system during pregnancy. [20] About 25% of patients with pre-eclampsia and 50% of individuals with eclampsia have visual system problems. Visual symptoms like blurred vision, scotomas, photopsia, diplopia and transient vision loss may indicate significant hypertension or neurological involvement. Fundus findings in pre-eclampsia may include retinal arteriolar narrowing, retinal hemorrhages, cotton wool spots, retinal edema, exudates, optic disc changes, and serous retinal detachment. [21]

Severe cases may also be associated with cortical visual impairment and posterior reversible encephalopathy syndrome (PRES). Therefore, visual symptoms occur with hypertension, severe headache, edema, seizures, or neurological abnormalities required urgent systemic and ophthalmic assessment. These should be distinguished from benign visual changes during pregnancy. [22]

Central serous chorioretinopathy CSCR

A fluid-filled detachment of the neurosensory retina caused by focal leakage at the retinal epithelial level is known as CSCR. A higher risk of CSCR during pregnancy may be linked to elevated cortisol levels and/or other hormonal changes, according to recent research. [23] CSCR can happen throughout any trimester of pregnancy, however, it most usually happens in the third trimester. According to previous study findings, central serous chorioretinopathy has an annual incidence of 0.008% and is an expected ocular complication of pregnancy. After delivery, it may spontaneously resolve. [1] Halos, fuzzy vision, and severe central vision metamorphopsia are just a few of the symptoms. Fluorescein angiography is not frequently utilised for diagnosis since it is not regarded as a safe investigation in pregnancy. According to a recent study, optical coherence tomography (OCT) can be used to diagnose and track pregnant women with CSCR without endangering the unborn through fluorescein dye exposure. [24]

Diabetic retinopathy

Pregnancy is associated with increased rates and more severe cases of diabetic retinopathy, a common eye disease. DR can occur in pregnant patients with both type 1 and type 2 diabetes, but is more common in Type 1 diabetes, especially if there was pre-existing retinopathy. It can also be seen in patients who develop gestational diabetes, but this is less common, and patients with gestational diabetes may not require routine ophthalmologic examinations. [25] The known risk factors for progression of DR in pregnancy include duration of diabetes, control of glycosylated haemoglobin (HbA1c), baseline severity of retinopathy and the presence of associated risk factors such as hypertension and diabetic macular oedema. It has also been shown that women with type 1 diabetes have a worse DR than women with type 2 diabetes. [24]

DR often improves after delivery, but can also worsen during pregnancy. Diabetic macular oedema may develop or progress (especially in women with proteinuria or hypertension). Progression can be aided by increased blood flow in the retina and hormonal factors (VEGF activity associated with progesterone). Women with diabetes should get eye exams before pregnancy and have their retinas checked routinely during pregnancy. [25] More severe non-proliferative or proliferative DR require closer monitoring and consideration of laser photocoagulation before conception. Anti-VEGF treatment is generally avoided during pregnancy due to the lack of safety information. [26] It is preferable to stabilise DR before conception, and if surgery is required, this should ideally be avoided unless vision-threatening complications develop.

Retinal artery or vein occlusion

Preeclampsia and eclampsia are linked to a much greater prevalence of RVO in pregnancy, according to a study that revealed normal pregnancy is a protective factor rather than a risk factor for the development of RVO. [27] This is brought on by inadequate placental perfusion, which causes retinal vascular anomalies and endothelial dysfunction. With only 33 instances out of almost 1.8 million deliveries, the incidence of RVO during pregnancy is far lower than that of the general female population of the same age. [1]

Ocular Toxoplasmosis

Toxoplasma gondii is the cause of ocular toxoplasmosis, and pregnancy may raise the risk of reactivation because of immunological and hormonal changes. Retinochoroiditis may develop in 70–90% of newborns with congenital toxoplasmosis, which affects 30–50% of infants whose mothers contract the infection during pregnancy. [28] Although systemic disease is typically less severe with later infection, the chance of fetal transmission increases with gestational age, reaching 72% at 36 weeks compared with 6% at 13 weeks. Reactivation of ocular toxoplasmosis seldom results in fetal infection; if treatment is needed

during pregnancy, intravitreal clindamycin and dexamethasone may be administered. [24]

Neuro-Ophthalmic Manifestations

Idiopathic intracranial hypertension (IIH)

IIH is caused by elevated intracranial pressure in the absence of venous sinus thrombosis or space-occupying lesions. The cerebral spinal fluid composition of patients with IIH is normal. Due to the hormonal changes and weight increase that take place during the prenatal period, pregnancy is thought to be a risk factor for the onset and worsening of IIH. [29] Symptoms of IIH may include headache, nausea, pulsatile tinnitus and transient visual loss due to papilledema. The symptoms are the same as those of non-pregnant people. Among overweight females of reproductive age, the annual incidence of IIH is about 15 per 100,000. Moreover, the visual results are similar to those of non-pregnant patients. [30] The preferred medical treatment for IIH is oral acetazolamide, a carbonic anhydrase inhibitor with a Class B2 pregnancy category. Cleft palates have been linked to teratogenic effects. [31] Recurrence of IIH during pregnancy is thought to be rare (~5%), and whether pregnancy is a risk factor for recurrence of IIH independent of weight gain is unknown. Pregnant women with IIH are monitored by dilated fundal examination and computerised perimetry; the frequency of testing depends on the degree of field loss and papilloedema. International consensus guidelines recommend that women with mild to moderate papilloedema and minimal field loss should be seen for every one to three months; women with severe papilloedema and stable fields should be seen by a doctor at least every four weeks and every week if fields are unstable. [30]

Pregnancy is also associated with increased thrombotic risk, and cerebral venous sinus thrombosis should be considered in women presenting with headache, seizures, papilledema or neurological visual symptoms. Other neuro-ophthalmic conditions may include optic neuropathy, pituitary-related visual disturbances, and cortical visual impairment. [32]

Graves' disease

Graves' disease is the most frequent type of gestational hyperthyroidism, which affects up to 0.2% of pregnant women. Antibodies activating the thyroid-stimulating hormone receptor cause Graves' disease, an autoimmune disorder. [33] The most prevalent extrathyroidal consequence of Graves' disease is thyroid-associated orbitopathy, which can develop or worsen in 0.2% to 0.4% of pregnant women. This could be explained by an increase in orbital tissue volume during pregnancy due to physiological changes associated with hypervolemia. [34] Proptosis, lid lag, periorbital oedema, muscle fibrosis and enlargement, optic neuropathy, and lacrimal gland dysfunction are indicators of orbitopathy. Because pregnancy affects

thyroid physiology and laboratory testing, it might be challenging to make the right diagnosis. Additionally, because antithyroid medications may be teratogenic, controlling Grave's disease can be difficult. Nonetheless, anti-thyroid medications continue to be the primary therapy option for pregnant women with Grave's disease. [33]

Ocular Changes During Labour and Delivery

During labour, substantial physiological stress and repeated increases in intrathoracic and intra-abdominal pressure are produced, for which subconjunctival hemorrhage the common benign ocular finding that may occur around delivery is 10%. [35] Valsalva maculopathy, also known as Valsalva-related pressure elevation during labour, happens rarely and may contribute to premacular or retinal hemorrhage, producing sudden central visual disturbance.

In the past, there had been worries that during vaginal delivery women with high myopia, previous retinal tears, prior retinal detachment surgery have not been supported by sufficient evidence to justify assisted delivery solely on the basis of retinal history. Therefore, the decision regarding the mode of delivery should be individualized and should not automatically be based on previous retinal disease alone. [36]

Postpartum Ocular Changes

As opposed to an instant restoration to the pre-pregnancy ocular status, the postpartum period is a phase of a gradual physiological recovery. After labour, a range of pregnancy-related modifications in the cornea, ocular surface, IOP, retinal blood supply, and choroid progressively regress. [15]

A measurable postpartum healing process can be observed by corneal evaluations. The reversible nature of gestational corneal thickening has been confirmed by recent prospective study findings that demonstrated the significant reduction in CCT and other pregnancy-related anterior segment changes during the postpartum period. After labour, corneal sensitivity and contact lens sensitivity may also reduce gradually. [37] Following labour, the normal drop of IOP observed during pregnancy generally restores. IOP elevate significantly after labour in comparison to late pregnancy, based on prospective data, indicating a return to the non-gestational condition. [38]

Precise measurements of choroidal regeneration have already been made. Subfoveal choroidal thickness decreased by around 41.9 μm through the third trimester and the postpartum period, indicating a reverse pattern of pregnancy-associated choroidal thickening, based on a recent study. [39] Moreover, postpartum retinal vascular adaptation may last for a few weeks. The relative retinal vasoconstriction over the postpartum period in comparison with pregnancy is being shown by OCTA examinations, suggesting the retinal circulation changes gradually

compared to immediately returning to its normal state post-delivery. [40]

After pregnancy, refractive state may also gradually improve. Following sufficient stability of ocular features, permanent spectacle changes, contact lens refitting procedures and selective refractive surgery should frequently be explored since corneal hydration and other anterior segment parameters might remain impacted during the early postpartum recovery.

Significantly, there is still ocular risks throughout the postpartum period. Following delivery, hypertensive, inflammatory, retinal, and neuro-ophthalmic conditions can persist or develop clinically. Appropriate clinical assessment is required for frequent occurrences of visual field abnormalities, blurred vision, flashes, floaters, sudden loss of vision, or severe headaches linked to visual problems.

Conclusion

Pregnancy can change the eyes in many ways due to changes in the body's hormones, blood vessels, metabolism and immune system. Some may take time to get back to their pre-pregnancy selves but most of these changes are temporary and will improve gradually after delivery. Pre-existing or pregnancy-related ocular conditions that may threaten vision may also be affected by pregnancy. Hence, the differentiation between adverse circumstances and physiological changes is important for correct diagnosis and follow-up. Regular eye examinations, timely referrals, and careful selection of ophthalmic drugs can protect maternal vision and fetal health. Generally, an understanding of ocular changes in pregnancy among optometrists and ophthalmologists is the foundation of safe and effective eye care in pregnancy and the postpartum period.

Conflict of Interest

The authors declare that they have no conflict of interest related to this study, its findings, or the publication of this manuscript.

Funding

The authors received no specific funding for this study. The research was conducted without financial support from any public, commercial, or not-for-profit funding agency.

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