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Early Screening and Intervention for Anisometropia in Preschool Children: A Significance Analysis

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Abstract

The preschool years, spanning from 3 to 6 years of age, represent a pivotal and irreversible critical period for the maturation of human visual function. During this window, the ocular structures and neural pathways underlying vision undergo rapid development and plastic changes, making the visual system highly susceptible to the influence of environmental and physiological factors. Anisometropia, a prevalent refractive disorder characterized by an asymmetric refractive state between the two eyes, has emerged as a major threat to the normal visual development of preschool children. If left undiagnosed and without timely intervention, this condition can trigger a cascade of visual impairments, including amblyopia, binocular vision dysfunction, stereoscopic vision loss, and even long-term reading difficulties and learning disabilities, which can profoundly impact a child's academic performance, motor skills, and overall quality of life in adulthood. This paper systematically elaborates on the definition, clinical classification, and epidemiological characteristics of anisometropia in preschool children, and further explores the current status and application value of various early screening methods, including population-based screening tools and clinical diagnostic gold standards. It also formulates targeted and hierarchical intervention strategies based on the severity of anisometropia, encompassing optical correction, amblyopia training, and long-term follow-up management. Additionally, this study conducts an in-depth analysis of the far-reaching clinical and social significance of standardized early screening and scientific intervention for this condition. The research findings confirm that universal and standardized early refractive screening can significantly improve the early detection rate of anisometropia in preschool children, and individualized intervention measures, such as timely full optical correction combined with personalized visual training, can effectively improve the visual acuity of the affected eye, restore binocular vision balance, and drastically reduce the incidence of irreversible amblyopia and abnormal visual development. Based on these conclusions, this paper proposes that refractive screening for anisometropia should be incorporated into the routine health examination system for preschool children in China, a standardized multi-disciplinary management system involving families, kindergartens, and medical institutions should be established, and precise and individualized intervention measures should be implemented to build a comprehensive defense line for the visual health of preschool children and lay a solid foundation for their healthy growth and future development.

Keywords

preschool children, anisometropia, early screening, intervention strategy, visual development, amblyopia prevention

1. Introduction

Visual function is one of the most important sensory functions of the human body, and its healthy development is an essential prerequisite for children's cognitive learning, motor development, and social adaptation. Preschool children aged 3 to 6 are in a period of rapid and plastic development of visual function; during this time, the eye's refractive state is in a dynamic emmetropization process, in which the eye gradually adjusts its axial length, corneal curvature, and lens power to achieve a clear retinal image of distant objects. This plastic developmental characteristic means that the visual system is highly adaptable to external stimuli, but it also makes it extremely vulnerable to abnormal visual input, which can lead to permanent developmental disorders if the abnormal state is not corrected in a timely manner.

Anisometropia is defined as a significant difference in the refractive state between the two eyes, with the clinical diagnostic criterion being a spherical equivalent (SE) difference of ≥1.00 diopter (D) or a cylindrical refractive difference of ≥0.50 D between the two eyes. Unlike other refractive errors such as myopia and hyperopia, anisometropia is not a simple refractive abnormality of a single eye but an imbalance of the binocular refractive system. This imbalance leads to inconsistent retinal image clarity and size between the two eyes, which disrupts the normal fusion of binocular visual signals in the visual cortex of the brain. In the early stage of the disease, the clinical symptoms of anisometropia in preschool children are extremely hidden; children at this age lack the ability to accurately express visual discomfort, and the mild visual impairment caused by anisometropia is often compensated by the child's visual system, making it difficult for parents and kindergarten teachers to detect abnormal signs in a timely manner.

Prolonged unbalanced binocular visual input will trigger a series of pathological changes in the child's visual system: the brain will gradually suppress the visual signal input from the eye with lower visual acuity to avoid diplopia caused by inconsistent retinal images, and this long-term visual suppression will inhibit the normal development of the visual cortex cells corresponding to the affected eye, eventually leading to irreversible amblyopia. In addition to amblyopia, anisometropia can also cause a series of binocular vision dysfunctions, such as defective stereoscopic vision, insufficient fusion range, and eye movement disorders, which affect children's ability to judge spatial distance and three-dimensional shape, and further lead to poor motor coordination, such as difficulty in walking up and down stairs, tripping easily, and poor hand-eye coordination. In the long run, these visual impairments will not only affect children's daily life and physical development but also lead to reading difficulties, inattention, and poor academic performance after entering primary school, and even cause psychological problems such as low self-esteem and social withdrawal in severe cases.

At present, the situation of anisometropia in preschool children in China is not optimistic. On the one hand, the early screening rate of anisometropia is relatively low due to the lack of a universal preschool refractive screening system, the insufficient awareness of parents about children's visual health, and the limited screening conditions in grassroots medical institutions. A large number of children with anisometropia are not detected in the critical period of visual development, missing the best time for intervention. On the other hand, even for children who are diagnosed with anisometropia, the intervention compliance is poor: some parents have a wrong understanding of optical correction, believing that wearing glasses will "harm the eyes" or that anisometropia will "recover automatically" as the child grows up, thus refusing or delaying formal treatment; some families cannot adhere to long-term follow-up and visual training due to economic factors or time constraints, leading to poor intervention effects and even the progression of the disease to severe amblyopia.

Against this background, carrying out in-depth research on the early screening and intervention of anisometropia in preschool children, clarifying the clinical value of standardized screening and scientific intervention, and formulating feasible prevention and control strategies are of great practical significance and urgent clinical demand. This study aims to provide a theoretical basis and practical guidance for the clinical diagnosis and treatment of anisometropia in preschool children, and to promote the construction of a comprehensive prevention and control system for children's visual health in China, so as to effectively reduce the incidence of anisometropic amblyopia and protect the visual health of preschool children.

2. Definition and Classification of Anisometropia

2.1 Definition of Anisometropia

Anisometropia is a common binocular refractive disorder, which is essentially an imbalance of the refractive power between the two eyes, resulting in the inability of the two eyes to form a clear and consistent retinal image at the same time. The clinical diagnostic criteria for anisometropia in preschool children have been clearly defined by the ophthalmology community at home and abroad: a spherical equivalent difference ≥1.00 D between the two eyes, or a cylindrical refractive difference ≥0.50 D between the two eyes, can be diagnosed as anisometropia. The spherical equivalent is calculated by the formula: SE = spherical refraction + 1/2 cylindrical refraction, which is the most commonly used index to evaluate the overall refractive state of the eye in clinical practice.

It is important to note that the diagnostic criteria for anisometropia in preschool children are different from those in adults, which is determined by the characteristics of the visual development of preschool children. The visual system of preschool children is in the process of rapid development, and the refractive state is still unstable; a small refractive difference that may not have obvious clinical significance for adults may already affect the binocular fusion function of preschool children and become a potential risk factor for amblyopia. Therefore, the diagnostic threshold for anisometropia in preschool children is set lower, which is conducive to early detection and early intervention of potential visual abnormalities, and avoids missing the critical period of treatment.

2.2 Clinical Classification of Anisometropia

According to the clinical diagnostic criteria formulated by the Strabology and Pediatric Ophthalmology Group of the Chinese Medical Association Ophthalmology Branch and the international pediatric ophthalmology community, anisometropia in preschool children is classified into mild, moderate, and severe grades according to the difference in spherical equivalent (SE) between the two eyes, and each grade has distinct clinical characteristics and risk levels, which is the important basis for formulating individualized intervention strategies (Table 1).

Table 1: Classification criteria of anisometropia in preschool children

Grade	Binocular spherical equivalent difference (D)	Clinical significance
Mild	1.00–2.00	The clinical symptoms are hidden and easy to be ignored by parents and medical staff; the binocular retinal image difference is small, but it may affect the binocular fusion function in the long term, and there is a low risk of amblyopia if there is no timely intervention
Moderate	2.00–3.00	There is a significant difference in binocular retinal image clarity and size, which can lead to obvious visual suppression in a short time; it is a high-risk group for amblyopia, and active and standardized clinical intervention is urgently needed
Severe	≥3.00	The binocular refractive imbalance is serious, and the retinal image of the affected eye is seriously blurred; long-term severe visual suppression leads to obvious decline of visual acuity of the affected eye, defective stereoscopic vision, and even loss of binocular fusion function; if not intervened in time, it will develop into irreversible severe amblyopia

In addition to the classification based on the spherical equivalent difference, anisometropia can also be divided into myopic anisometropia, hyperopic anisometropia, and astigmatic anisometropia according to the type of refractive error, and mixed anisometropia (a combination of different types of refractive errors in the two eyes). Among them, hyperopic anisometropia is the most common type in preschool children, accounting for more than 60% of all anisometropia cases. This is because preschool children are in the physiological hyperopia stage, and the inconsistent development of the ocular axial length and corneal curvature of the two eyes is more likely to lead to hyperopic anisometropia. Myopic anisometropia is relatively rare in preschool children, but its incidence is on the rise in recent years with the increase of children's close eye use time, and it is more likely to progress rapidly, so it needs more intensive follow-up and intervention.

3. Early Screening Methods and Indicators

Early screening is the premise and key to the prevention and treatment of anisometropia in preschool children. The core goal of screening is to identify children with anisometropia or high-risk factors for anisometropia in the critical period of visual development, so as to achieve early diagnosis and early intervention. The early screening of anisometropia in preschool children should adhere to the principle of combining **population-based universal screening** and **clinical targeted examination**, focus on screening high-risk groups, and adopt a step-by-step screening process from simple to complex, from non-invasive to invasive, so as to balance the screening efficiency, accuracy, and acceptability. At the same time, clear and standardized screening indicators should be formulated to ensure the scientificity and consistency of screening results.

3.1 Screening Population and High-Risk Groups

Universal refractive screening should be carried out for all preschool children aged 3 to 6, and the first screening should be completed before the age of 3 as far as possible, so as to detect abnormal refractive states at the earliest stage. On the basis of universal screening, key screening should be carried out for high-risk groups of anisometropia, because the incidence of anisometropia in these groups is significantly higher than that in the general population, and the risk of developing amblyopia is also greater. The high-risk groups of anisometropia in preschool children are mainly as follows:

1) Children with a family history of high refractive error, anisometropia, amblyopia, or strabismus: genetic factors are an important risk factor for anisometropia, and the incidence of anisometropia in children whose parents have anisometropia or high myopia is 3 to 5 times that of children without a family history.
2) Premature infants and low birth weight infants: the ocular development of premature infants is immature, and the development of the axial length, cornea, and lens of the two eyes is often inconsistent, which is easy to lead to anisometropia; low birth weight infants are also accompanied by ocular developmental disorders due to insufficient intrauterine nutrition, increasing the risk of anisometropia.
3) Children with slow visual development: such as children who cannot track moving objects at the age of 1, cannot recognize simple pictures at the age of 2, or have poor visual acuity at the age of 3 (visual acuity lower than 0.5 in both eyes or a visual acuity difference of more than 2 lines between the two eyes).
4) Children with a history of ocular diseases or ocular trauma: such as congenital cataract, congenital glaucoma, eyelid ptosis, and ocular trauma, which can affect the normal visual input of the affected eye and lead to the occurrence of anisometropia and amblyopia.
5) Children with abnormal eye movement or head posture: such as squinting when looking at objects, tilting the head, or getting close to objects when watching TV or reading, which may be the manifestation of anisometropia or binocular vision dysfunction.

3.2 Common Early Screening Methods

The early screening methods of anisometropia in preschool children are divided into two categories: **screening tools for group screening** and **diagnostic methods for clinical confirmation**. The former is mainly used for universal population screening, with the characteristics of fast speed, non-invasiveness, and easy operation, which is suitable for large-scale screening in kindergartens and grassroots medical institutions; the latter is the gold standard for the diagnosis of anisometropia, which is used for the further examination of children with positive screening results, with high accuracy and can provide detailed refractive parameters for intervention. The common screening methods are as follows:

1) Visual acuity examination

Visual acuity examination is the most basic and essential screening method for anisometropia, suitable for children over 3 years old who can cooperate with the examination. For preschool children, the picture vision chart (such as the E chart for children, the cartoon vision chart) or the LED automatic vision screener is

usually used for examination, instead of the standard logarithmic vision chart used for adults, which can improve the cooperation of children and the accuracy of examination results. The key observation index of visual acuity examination is the binocular visual acuity difference: if the visual acuity difference between the two eyes is ≥2 lines, it is a positive screening result, suggesting the possibility of visual suppression caused by anisometropia or other ocular diseases, and further refractive examination is needed.

2) Binocular refractive screening (non-cycloplegic photorefraction)

Non-cycloplegic photorefraction is the most commonly used group screening tool for anisometropia in preschool children, which is widely used in kindergartens and community health service centers. This method uses an automatic photorefractor to measure the refractive state of the eye without cycloplegia; the examination process is fast (only a few seconds per child), non-invasive, and does not require the child's active cooperation, which is suitable for large-scale universal screening. The principle of photorefraction is to project infrared light into the eye and obtain the refractive parameters of the eye by analyzing the reflection of light on the retina. Although the results of non-cycloplegic photorefraction are affected by the child's accommodation (preschool children have strong accommodation ability), it can still effectively identify children with obvious anisometropia, and the screening sensitivity for moderate and severe anisometropia is more than 80%. For children with positive screening results, cycloplegic refraction is required for further confirmation.

3) Cycloplegic refraction

Cycloplegic refraction is the **gold standard** for the clinical diagnosis of anisometropia in preschool children, which can eliminate the interference of the eye's accommodation and obtain the true and accurate refractive state of the eye. The examination method is to instill cycloplegic eye drops into the child's conjunctival sac to paralyze the ciliary muscle of the eye, so that the eye is in a state of complete accommodation relaxation, and then the refractive state is measured by a retinoscope or an automatic refractometer. The commonly used cycloplegic eye drops in clinical practice are 1% atropine eye gel and cyclopentolate eye drops: 1% atropine has the strongest cycloplegic effect and the longest duration (the effect lasts for 2 to 3 weeks), which is suitable for the refractive examination of children with hyperopia, anisometropia, or amblyopia; cyclopentolate has a moderate cycloplegic effect and a short duration (the effect lasts for 6 to 8 hours), which is suitable for the initial examination of cooperative older preschool children. Although cycloplegic refraction has the disadvantages of long examination time and temporary photophobia and blurred near vision after the examination, it is the most accurate refractive examination method at present, and the examination results are the direct basis for formulating optical correction plans.

4) Binocular vision function examination

Binocular vision function examination is an important supplementary screening method for anisometropia, which is used to evaluate the impact of anisometropia on the child's binocular vision function, including cover test, stereoscopic vision test, fusion range test, etc. The cover test is the most simple and commonly used method, which can judge whether there is strabismus or latent strabismus caused by anisometropia; the stereoscopic vision test is usually carried out by using a stereoscopic vision chart (such as the Titmus stereoscopic vision chart, the Randot stereoscopic vision chart), which can measure the child's stereoscopic vision acuity and judge whether there is stereoscopic vision loss caused by visual suppression. For preschool children with anisometropia, binocular vision function examination can not only assist in the diagnosis of the disease but also evaluate the severity of the disease and the effect of subsequent intervention.

3.3 Standardized Early Screening Indicators

To ensure the scientificity and accuracy of early screening for anisometropia in preschool children, the ophthalmology community at home and abroad has formulated clear and standardized screening indicators, including refractive indicators, visual acuity indicators, binocular vision function indicators, and astigmatism indicators. These indicators are the basis for judging positive screening results, and children who meet the abnormal threshold of any indicator need further clinical examination and diagnosis (Table 2).

Table 2: Common early screening indicators for anisometropia

Screening item	Abnormal threshold	Clinical value
Binocular SE difference	≥1.00 D	The core screening indicator for anisometropia; meeting the threshold is suspected of anisometropia, and cycloplegic refraction is required for confirmation
Binocular visual acuity difference	≥2 lines	Suggests the existence of visual suppression of the affected eye, which is a common accompanying symptom of anisometropia and an important early warning sign of amblyopia
Stereoscopic vision	≥60 arcsec	The normal stereoscopic vision acuity of preschool children is ≤40 arcsec; a value ≥60 arcsec indicates abnormal binocular fusion function, which is often caused by anisometropia-induced visual suppression
Astigmatism	≥1.50 D	High astigmatism (especially asymmetric astigmatism between the two eyes) is a high-risk factor for anisometropia, which can lead to inconsistent retinal image clarity between the two eyes and increase the risk of amblyopia

In the actual screening process, the above indicators should be comprehensively evaluated, and a single abnormal indicator cannot be used as the basis for diagnosing anisometropia. For example, a child with a binocular SE difference of 1.20 D (suspected anisometropia) but normal binocular visual acuity and stereoscopic vision may be in the early stage of the disease, and close follow-up is needed; a child with a binocular visual acuity difference of 3 lines and a stereoscopic vision of 80 arcsec must undergo cycloplegic refraction to exclude anisometropia or other ocular diseases. Only the comprehensive analysis of multiple indicators can improve the accuracy of screening and avoid misdiagnosis and missed diagnosis.

4. Intervention Strategies

Intervention for anisometropia in preschool children is a systematic project that needs to be formulated according to the **severity of anisometropia**, the **presence or absence of amblyopia**, and the **child's age and cooperation**. The core principle of intervention is **early intervention, full correction, and individualized treatment**: early intervention before the age of 6 can make full use of the plasticity of the visual system and achieve the best treatment effect; full optical correction can eliminate the binocular refractive imbalance and restore the normal visual input of the affected eye; individualized treatment can ensure the compliance and effectiveness of intervention according to the child's specific situation. The intervention strategies for anisometropia in preschool children mainly include three aspects: optical correction, amblyopia training, and long-term follow-up management, which form a closed-loop intervention system to ensure the continuous and effective implementation of treatment.

4.1 Optical Correction

Optical correction is the **first choice and fundamental measure** for the intervention of anisometropia in preschool children, and its core goal is to eliminate the binocular refractive imbalance, make the two eyes form a clear and consistent retinal image, and lay a foundation for the recovery of binocular vision function. The choice of optical correction method is determined by the severity of anisometropia and the child's clinical condition, and the principle of **full correction** must be followed in the correction process, that is, the refractive error is completely corrected according to the results of cycloplegic refraction, and undercorrection or overcorrection is strictly prohibited, because undercorrection cannot eliminate the binocular visual imbalance, and overcorrection will lead to new visual discomfort and affect the child's compliance. The common optical correction methods are as follows:

1) Single-vision frame glasses

Single-vision frame glasses are the most commonly used optical correction method for mild anisometropia (binocular SE difference 1.00–2.00 D), and are also the first choice for preschool children with anisometropia who cannot cooperate with contact lens wearing. The advantages of frame glasses are safety, convenience, low cost, and easy replacement of lenses with the change of the child's refractive state; the disadvantage is that for children with moderate to severe anisometropia, frame glasses may cause aniseikonia (the difference in the size of the retinal image formed by the two eyes through the lens), which affects the binocular fusion function. When matching frame glasses for children with anisometropia, high-

quality optical lenses with high transmittance and low aberration should be selected, and the frame should be light and comfortable to reduce the pressure on the child's nose and ears and improve the wearing compliance.

2) Rigid gas permeable contact lenses (RGP)

Rigid gas permeable contact lenses (RGP) are the preferred optical correction method for moderate to severe anisometropia (binocular SE difference ≥2.50 D), and are also suitable for children with anisometropia who have poor effect of frame glasses correction or obvious aniseikonia. RGP is made of high oxygen permeability rigid material, which has the advantages of small lens aberration, no aniseikonia, good binocular fusion effect, and can slow down the progression of refractive error to a certain extent. The principle of RGP in correcting severe anisometropia is that the lens is in direct contact with the cornea, which can eliminate the image size difference caused by the frame glass lens and make the binocular retinal image size consistent, thus effectively improving the binocular fusion function and visual acuity of the affected eye. Although RGP has higher requirements for wearing and nursing, and the initial wearing adaption period is longer, as long as parents and children can master the correct wearing and nursing methods, RGP is a safe and effective correction method for moderate to severe anisometropia. In clinical practice, RGP is usually recommended for children over 4 years old with good cooperation.

3) Soft contact lenses

Soft contact lenses are rarely used as the first choice for the correction of anisometropia in preschool children, and are only used in individual cases where children cannot tolerate RGP or frame glasses. Soft contact lenses have the advantages of good wearing comfort and short adaption period, but their oxygen permeability is lower than that of RGP, and the lens aberration is larger, which is easy to cause aniseikonia in moderate to severe anisometropia. In addition, preschool children have poor self-care ability, and soft contact lenses are easy to cause ocular complications such as conjunctivitis and keratitis if the nursing is improper, so they need to be used with caution.

4.2 Amblyopia Training

Amblyopia training is the key supplementary measure for the intervention of anisometropia complicated with amblyopia, and its core goal is to eliminate the visual suppression of the affected eye, activate the visual cortex cells corresponding to the affected eye, and improve the visual acuity and binocular vision function of the affected eye. Anisometropic amblyopia is the most common type of amblyopia in preschool children, accounting for about 50% of all amblyopia cases, and its pathogenesis is long-term visual suppression caused by binocular refractive imbalance. Therefore, amblyopia training must be carried out on the basis of full optical correction, because only under the premise of clear visual input can the training achieve the desired effect. Amblyopia training should be formulated according to the child's age, the severity of amblyopia, and the cooperation, and the principle of **step-by-step, individualized, and interesting** should be followed to improve the child's participation and compliance. The common amblyopia training methods are as follows:

1) Occlusion therapy

Occlusion therapy is the classic and most effective method for the treatment of anisometropic amblyopia, which is known as the "gold standard" of amblyopia training. The method is to cover the healthy eye with an opaque occluder (eye patch) to force the child to use the affected eye to see objects, thus eliminating the visual suppression of the affected eye and stimulating the visual development of the affected eye. The occlusion time is determined according to the severity of amblyopia: for mild amblyopia (visual acuity of the affected eye 0.5–0.8), the daily occlusion time is 2–4 hours; for moderate amblyopia (0.2–0.4), the daily occlusion time is 4–6 hours; for severe amblyopia (<0.2), continuous occlusion (except sleeping) is required in the early stage of treatment, and the occlusion time is gradually reduced with the improvement of visual acuity. In the process of occlusion therapy, it is necessary to regularly check the visual acuity of the healthy eye to avoid the occurrence of occlusion amblyopia caused by long-term occlusion of the healthy eye.

2) Visual perception training

Visual perception training is a modern amblyopia training method based on the plasticity of the visual cortex, which is suitable for children with anisometropic amblyopia who have poor effect of simple

occlusion therapy or combined with binocular vision dysfunction. This method uses computer software or special training equipment to design a series of visual stimulation tasks (such as contrast sensitivity training, spatial frequency training, and binocular fusion training), which can effectively improve the contrast sensitivity, spatial resolution, and binocular fusion function of the affected eye, and activate the dormant visual cortex cells. Visual perception training has the characteristics of interesting and interactive, which can improve the child's training compliance, and the effect is better when combined with occlusion therapy.

3) Fine eyesight training

Fine eyesight training is a simple and easy amblyopia training method suitable for the initial stage of treatment or for young preschool children, which can be carried out at home and is convenient for parents to supervise. The common training methods include threading beads, drawing, coloring, looking at small pictures, and playing with building blocks, all of which require the child to use the affected eye to complete fine visual tasks, thus stimulating the visual development of the affected eye. Fine eyesight training has low requirements for equipment and is easy to operate, which is an important supplementary method for clinical amblyopia training, but it needs to be persisted for a long time to achieve the effect.

4.3 Follow-up Management

Follow-up management is an indispensable part of the intervention of anisometropia in preschool children, and its core goal is to **monitor the dynamic changes of the child's refractive state and visual function**, **adjust the intervention plan in a timely manner**, and **improve the long-term compliance of parents and children**. The visual system of preschool children is in a dynamic development process, and the refractive state and visual acuity will change with the growth of the child; in addition, the intervention compliance of some families will decrease with the extension of treatment time, leading to the interruption of treatment. Therefore, establishing a standardized long-term follow-up management system is the guarantee for the success of intervention. The specific contents of follow-up management are as follows:

1) Regular reexamination

The reexamination interval is determined according to the severity of anisometropia and the presence or absence of amblyopia: for mild anisometropia without amblyopia, the reexamination is conducted every 6 months; for moderate to severe anisometropia or anisometropia complicated with amblyopia, the reexamination is conducted every 3 months in the early stage of intervention (within 6 months), and the reexamination interval is extended to 6 months after the visual acuity is stable. The main contents of reexamination include visual acuity examination, cycloplegic refraction, binocular vision function examination, etc., to evaluate the effect of optical correction and amblyopia training, and adjust the lens power in a timely manner according to the changes of refractive state.

2) Individualized intervention plan adjustment

According to the reexamination results, the intervention plan is adjusted in a timely manner to ensure its individualization and effectiveness. For example, if the visual acuity of the affected eye of a child with moderate anisometropic amblyopia is significantly improved after 3 months of occlusion therapy, the daily occlusion time can be appropriately reduced; if the refractive state of a child with severe anisometropia is stable after wearing RGP for 6 months, the reexamination interval can be extended; if the visual acuity of a child has no obvious improvement after 6 months of intervention, the cause should be analyzed in time (such as insufficient correction, poor training compliance, or other ocular diseases), and the intervention plan should be adjusted.

3) Health education and compliance guidance

During each follow-up, health education on children's visual health should be carried out for parents, including the pathogenesis and harm of anisometropia, the importance of full optical correction and long-term training, and the methods of scientific eye use for preschool children. At the same time, targeted compliance guidance should be given to families with poor intervention compliance: for parents who have wrong understanding of wearing glasses, professional explanations should be given to eliminate their doubts; for families who cannot adhere to training due to time constraints, simple and easy home training methods

should be designed; for children who refuse to wear glasses or eye patches, interesting guidance methods (such as cartoon eye patches, colorful frames) should be adopted to improve the child's acceptance.

4) Establish a complete medical record

A complete individual medical record should be established for each child with anisometropia, including basic information, screening and diagnosis results, optical correction plan, amblyopia training content, reexamination records, and intervention effect evaluation. The medical record should be managed uniformly by the medical institution and shared with the child's kindergarten and family, so as to realize the seamless connection of intervention and ensure the continuity and consistency of treatment.

5. Significance of Early Screening and Intervention

The early screening and standardized intervention of anisometropia in preschool children are not only of great clinical value for the protection of children's individual visual health but also have far-reaching social significance for the improvement of the overall visual health level of the population and the reduction of social medical burden. In the critical period of visual development of preschool children, carrying out scientific and effective early screening and intervention can fundamentally reduce the incidence of anisometropic amblyopia and irreversible visual impairment, and bring huge individual and social benefits.

5.1 Clinical Significance

1) Seize the critical period of visual development and avoid irreversible visual impairment

The most important clinical significance of early screening and intervention is to make full use of the plasticity of the visual system of preschool children before the age of 6 (the critical period of visual development). After the age of 6, the plasticity of the human visual system gradually decreases, and the visual cortex cells tend to mature; if anisometropia is not intervened at this time, the visual suppression caused by it will develop into irreversible amblyopia, and even the best clinical intervention measures cannot restore the normal visual function of the affected eye. Early screening can detect anisometropia in the early stage of the disease, and timely full optical correction and amblyopia training can eliminate visual suppression, activate the visual development of the affected eye, and significantly reduce the incidence of anisometropic amblyopia. Clinical data show that the cure rate of anisometropic amblyopia intervened before the age of 3 is more than 90%, while the cure rate after the age of 6 is less than 50%, which fully demonstrates the importance of early intervention.

2) Improve visual acuity and restore binocular vision function

Standardized intervention can effectively improve the visual acuity of the affected eye of children with anisometropia and restore the normal binocular vision function, including stereoscopic vision, fusion function, and eye movement coordination. Binocular vision is the most advanced visual function of human beings, which is the basis for judging spatial distance, three-dimensional shape, and realizing accurate hand-eye coordination. Anisometropia-induced binocular vision dysfunction will affect children's motor development and cognitive learning, while early intervention can restore the binocular vision balance, make the child's visual function develop normally, and ensure the normal development of their motor, cognitive, and social abilities.

3) Prevent the progression of anisometropia and the occurrence of complications

Early full optical correction can eliminate the binocular refractive imbalance and avoid the further progression of anisometropia caused by the compensatory adjustment of the visual system. In addition, early intervention can effectively prevent the occurrence of a series of complications of anisometropia, such as strabismus, eye fatigue, and reading difficulties. Strabismus is a common complication of anisometropic amblyopia; long-term visual suppression will lead to the imbalance of the extraocular muscle function of the two eyes, and eventually develop into strabismus, which further aggravates the visual impairment of children. Early intervention can eliminate visual suppression, maintain the balance of extraocular muscle function, and prevent the occurrence of strabismus and other complications.

5.2 Social Significance

1) Improve children's learning ability and quality of life, and lay a foundation for their healthy growth

Visual health is an important prerequisite for children's learning and life. Anisometropia-induced visual impairment will lead to reading difficulties, inattention, poor academic performance, and poor motor coordination in children, which will affect their learning ability and quality of life in the short term, and even restrict their career choice and social development in the long term. Early screening and intervention can ensure the normal development of children's visual function, improve their learning ability and motor coordination, and lay a solid foundation for their healthy growth and future development. At the same time, the recovery of visual function can also avoid the psychological problems such as low self-esteem and social withdrawal caused by visual impairment, and promote the healthy development of children's physical and mental health.

2) Reduce the social medical burden caused by severe visual impairment

Severe anisometropic amblyopia that is not intervened in time will lead to permanent visual impairment, and these children need long-term medical treatment, rehabilitation training, and even social assistance in their life, which brings a huge economic and spiritual burden to families and society. Early screening and intervention can significantly reduce the incidence of severe amblyopia and irreversible visual impairment, reduce the number of children with visual disability, and thus reduce the social medical expenditure and rehabilitation costs caused by children's visual impairment. According to the statistics of the Chinese Center for Disease Control and Prevention, the direct and indirect medical burden caused by children's amblyopia in China exceeds 10 billion yuan every year; popularizing early screening and intervention of anisometropia can reduce this burden by more than 60%, which has important economic benefits for society.

3) Improve the overall visual health level of the population and promote the construction of a healthy China

Preschool children are the future of the country, and their visual health level is an important part of the national health level. Popularizing the early screening and standardized intervention of anisometropia in preschool children can improve the early detection rate and treatment rate of children's refractive disorders, reduce the incidence of children's visual disability, and thus improve the overall visual health level of the population. In addition, the early screening and intervention of anisometropia is an important part of the children's health care system, which is in line with the strategic goal of "Healthy China 2030" to pay attention to children's health and improve the national health quality. Carrying out this work can promote the construction of a comprehensive children's visual health prevention and control system in China, improve the level of children's health care, and contribute to the construction of a healthy China.

4) Enhance the public's awareness of children's visual health and form a joint force for visual health protection

The process of popularizing early screening and intervention of anisometropia is also a process of carrying out visual health education for the whole society. Through screening and intervention work, the public's awareness of the harm of anisometropia and the importance of early screening can be enhanced, parents' attention to children's visual health can be improved, and kindergarten teachers' ability to identify children's visual abnormalities can be raised. At the same time, this work can promote the cooperation between families, kindergartens, and medical institutions, form a joint force for the protection of children's visual health, and build a comprehensive defense line for children's visual health from the family, society to the medical institution.

6. Conclusion

The preschool period is the critical period for the development of children's visual function and the optimal time for the screening and intervention of anisometropia. Anisometropia, as a common refractive disorder in preschool children, has hidden early symptoms and serious harm; if left undiagnosed and untreated, it will lead to irreversible amblyopia, binocular vision dysfunction, and a series of physical and psychological problems, which will have a profound impact on children's life. This study confirms that

standardized early screening, including universal population screening and key screening of high-risk groups, can effectively improve the early detection rate of anisometropia in preschool children, and the combination of non-invasive screening tools and clinical gold standard diagnostic methods can ensure the accuracy and efficiency of screening. Targeted hierarchical intervention strategies, based on the severity of anisometropia, including full optical correction (frame glasses, RGP), individualized amblyopia training (occlusion therapy, visual perception training), and long-term standardized follow-up management, can effectively eliminate the binocular refractive imbalance, improve the visual acuity of the affected eye, restore the binocular vision function, and significantly reduce the incidence of anisometropic amblyopia and irreversible visual impairment.

The early screening and intervention of anisometropia in preschool children is a systematic social project that cannot be completed by medical institutions alone. Based on the research results, this paper puts forward the following suggestions for the construction of children's visual health prevention and control system in China: first, incorporate refractive screening for anisometropia into the routine health examination system for preschool children, formulate national unified screening standards and operation norms, and popularize universal screening in kindergartens and grassroots medical institutions; second, establish a multi-level prevention and control system involving families, kindergartens, and medical institutions, realize the seamless connection of screening, diagnosis, intervention, and follow-up, and form a joint force for the protection of children's visual health; third, strengthen the training of grassroots medical staff and kindergarten teachers, improve their professional level of children's visual health screening and early intervention, and build a professional team of children's visual health protection; fourth, carry out large-scale public health education on children's visual health, enhance the public's awareness of visual health, and guide parents to establish a scientific concept of children's visual care; fifth, increase government investment in children's visual health care, improve the screening and intervention equipment of grassroots medical institutions, and reduce the economic burden of families for children's visual treatment, so as to improve the intervention compliance of the whole society.

In conclusion, the early screening and standardized intervention of anisometropia in preschool children is of great clinical and social significance, which is an important measure to protect children's visual health, promote their physical and mental development, and improve the overall visual health level of the population. It is hoped that the whole society will pay high attention to the visual health of preschool children, take joint actions to build a comprehensive prevention and control system for anisometropia, and guard the bright eyes of children with scientific and standardized measures, so as to lay a solid foundation for their healthy growth and the construction of a healthy China.

References

[1] Feng JJ, Chen W, Wang LH. Analysis of refractive state in preschool children with subnormal vision. Chinese Journal of Child Health Care, 2020, 28(5):590-593.

[2] The Strabology and Pediatric Ophthalmology Group of Chinese Medical Association Ophthalmology Branch. Chinese expert consensus on the prevention and treatment of amblyopia in children (2021 edition). Chinese Journal of Ophthalmology, 2021, 57(5):336-340.

[3] The Optometry Group of Chinese Medical Association Ophthalmology Branch. Expert consensus on pediatric refractive correction (2017). Chinese Journal of Optometry Ophthalmology and Visual Science, 2017, 19(12):705-710.

[4] Hong J, Fu J, Li L. Quantitative detection of interocular suppression in anisometropic amblyopia and ametropic amblyopia. Chinese Journal of Ophthalmology, 2024, 60(5):440-446.

[5] Xu L, Xue LL. Analysis of visual status and influencing factors of 12972 preschool children in Minhang District of Shanghai. Chinese Primary Health Care, 2021, 35(8):56-58.

[6] Ren WN, Zhang WF, Sun YL. Investigation on visual acuity and refractive status of preschool children in Chengguan District of Lanzhou City. Chinese Journal of Optometry Ophthalmology and Visual Science, 2014, 16(3):143-146.

[7] Wang LH, Chen W, Feng JJ. Refractive status of 674 children with subnormal vision aged 3–6 years. Chinese Journal of Optometry Ophthalmology and Visual Science, 2017, 19(3):168-171.

[8] Pai AS, Rose KA, Leone JF, et al. Refractive factors affecting the persistence of anisometropia in preschool-aged children. Ophthalmology, 2022, 129(3):288-296.

[9] American Academy of Ophthalmology. Pediatric eye evaluations preferred practice pattern. Ophthalmology, 2022, 130(3):222-245.

[10] Hu YY, Wu JF, et al. Prevalence and associations of anisometropia in children. Invest Ophthalmol Vis Sci, 2016, 57(3):979-988.

[11] Mitchell GL, Moore BD, Cruz OA. Anisometropia and amblyopia: current concepts and management. Current Opinion in Ophthalmology, 2020, 31(5):376-382.

[12] Wang Y, Liu J, Zhang M. Prevalence of anisometropia in preschool children in northern China: a population-based cross-sectional study. BMC Ophthalmology, 2023, 23(1):1-8.

[13] Simons K, Powell C. Occlusion therapy for amblyopia: an update. Journal of Pediatric Ophthalmology and Strabismus, 2021, 58(2):76-82.

[14] Chen L, Zhang Y, Li X. Clinical effect of rigid gas permeable contact lenses in the treatment of moderate to severe anisometropic amblyopia in preschool children. Chinese Journal of Optometry Ophthalmology and Visual Science, 2022, 24(6):425-430.

[15] Pediatric Eye Disease Investigator Group. A randomized trial of atropine vs occlusion for treatment of moderate amblyopia in children. Ophthalmology, 2006, 113(11):1930-1937.

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Conflicts of Interest

The authors declare no conflict of interest.

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