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RANO OTKRIVANJE I EFIKASNO UPRAVLJANJE REFRAKCIONIM ANOMALIJAMA KOD DECE I ADOLESCENATA: PERSPEKTIVE, IZAZOVI I PREPREKE ZA INTERVENCIJU

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SAŽETAK

U okviru ovog preglednog rada analizirani su rezultati različitih istraživanja u oblasti ranog otkrivanja i efikasnog upravljanja refrakcionim anomalijama kod dece i adolscenata uzrasta 0-19 godina s ciljem smanjenja invaliditeta i unapređenja zdravlja organa čula vida. Refraktivne greške nastaju kada oko ne može pravilno da fokusira svetlost na mrežnjaču, što dovodi do zamućenog vida. Refraktivne greške uključuju miopiju (kratkovidost), hipermetropiju (dalekovidost) i astigmatizam. Globalno 448 miliona dece i adolescenata pati od refraktivnih anomalija. Većina njih može se lako ispraviti nošenjem naočara ili kontaktnih sočiva, a u nekim slučajevima i hiruskom intervenciom. Vizuelni poremećaji mogu imati ozbiljne i dugoročne posledice na fizički, mentalni i socijalni razvoj deteta. Efikasno upravljanje ovim problemima je ključno za očuvanje vida i poboljšanje obrazovnih i socijalnih aspekata života deteta.

Ključne reči: Refraktivne greške, prevencija, oftalmologija, skrining, deca.

Uvod

Na globalnom nivou, gubitak vida predstavlja ozbiljan zdravstveni problem koji se značajno odražava na kvalitet života. Prema podacima iz 2020. godine, procenjeno je da je 43,3 miliona ljudi bilo slepo, dok je 295 miliona imalo umereno do teško oštećenje vida, a 258 miliona blago oštećenje vida (1). Refraktivne greške nastaju kada postoji nesklad između dužine oka i njegove sposobnosti da pravilno prelama svetlost, što dovodi do zamućenog vida. Postoje četiri glavne vrste refraktivnih grešaka: kratkovidost (miopija), gde osoba jasno vidi objekte koji su blizu, ali su udaljeni objekti zamagljeni; dalekovidost (hipermetropija), kod koje su udaljeni objekti jasni, dok su bliži zamagljeni; astigmatizam, koji uzrokuje zamućenje vida na svim udaljenostima zbog nepravilnog oblika rožnjače ili sočiva; i presbiopija, povezana sa starenjem, koja otežava fokusiranje na bliske objekte i obično se javlja nakon 40. godine (1-11). Ako se ne koriguju, refraktivne greške su jedan od glavnih uzroka slepila širom sveta. Istraživanja pokazuju (2,3) da je nekorigovana refraktivna greška, posebno miopija (kratkovidost), najčešći uzrok oštećenja vida globalno, sa procenjenim brojem od 108 miliona pogođenih osoba u 2010. godini. Godišnji ekonomski teret nekorigovane miopije procenjuje se na 202 milijarde dolara (1,2).

Prema procenama Međunarodne agencije za prevenciju slepila (engl. *The International Agency for the Prevention of Blindness* - IAPB) (3), refraktivne greške predstavljaju jedan od ključnih zdravstvenih izazova kod dece i adolescenata uzrasta od 0 do 19 godina. Procenjuje se da oko 448 miliona dece i adolescenata pati od refraktivnih anomalija, od čega je 339,4 miliona pogođeno kratkovidošću (miopijom), dok 109,3 miliona ima

REVIEW ARTICLE

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EARLY DETECTION AND EFFECTIVE MANAGEMENT OF REFRACTIVE ANOMALIES IN CHILDREN AND ADOLESCENTS: PERSPECTIVES, CHALLENGES, AND BARRIERS TO INTERVENTION

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SUMMARY

This review paper analyzes the results of various studies on early detection and effective management of refractive errors in children and adolescents aged 0-19, with the aim of reducing disability and improving ocular health. Refractive errors occur when the eye cannot properly focus light onto the retina, resulting in blurred vision. These errors include myopia (nearsightedness), hypermetropia (farsightedness), and astigmatism. Globally, 448 million children and adolescents suffer from refractive errors. Most of these cases can be easily corrected with eyeglasses or contact lenses, and in some instances, surgical intervention. Visual impairments can have serious and long-lasting effects on the physical, mental, and social development of a child. Effective management of these issues is crucial for preserving vision and improving the educational and social aspects of child life.

Keywords: Refractive errors, prevention, ophthalmology, screening, children.

Introduction

Globally, vision loss is a serious health issue that significantly impacts quality of life. According to the data from 2020, it was estimated that 43.3 million people were blind, 295 million had moderate to severe visual impairment, and 258 million had mild visual impairment (1). Refractive errors occur when there is a mismatch between the length of the eye and its ability to properly focus light, which leads to blurred vision. There are four main types of refractive errors: myopia (nearsightedness), where a person can clearly see objects that are close, but distant objects appear blurred; hypermetropia (farsightedness), where distant objects are clear but nearby objects are blurred; astigmatism, which causes blurred vision at all distances due to an irregularly shaped cornea or lens; and presbyopia, age-related difficulty in focusing on close objects, usually occurring after the age of 40 (1-11). If left uncorrected, refractive errors are one of the leading causes of blindness worldwide. Research shows (2,3) that uncorrected refractive error, particularly myopia, is the most common cause of visual impairment globally, with an estimated number of 108 million affected people in 2010. The annual economic burden of uncorrected myopia is estimated at $202 billion (1,2).

According to the estimates of the International Agency for the Prevention of Blindness (IAPB) (3), refractive errors are one of the key health challenges in children and adolescents aged 0 to 19 years. It is estimated that around 448 million children and adolescents suffer from refractive anomalies, with 339.4 million affected by myopia, and 109.3 million having farsightedness (hypermetropia/hyperopia), both of which affect their vision. Additionally, the IAPB highlights that dalekovidost (hipermetropiju/hiperopija) koja utiče na njihov vid. Pored toga, IAPB ističe da oko 90 miliona dece i adolescenata živi sa različitim stepenom gubitka vida. U ovu grupu spadaju 2 miliona dece koja su slepa, 30 miliona sa umerenim do teškim oštećenjem vida, i 58 miliona dece sa blagim gubitkom vida (3). Važno je napomenuti da se ove dve brojke ne mogu sabirati jer predstavljaju različite kategorije i ne postoji precizan podatak o preklapanju između dece koja imaju refraktivne anomalije i onih sa gubitkom vida usled drugih uzroka (3,4). Prevalencija gubitka vida kod dece varira značajno unutar i između zemalja i regiona, ali je opšte smanjenje slepila kod dece prisutno u svim regionima, posebno zahvaljujući smanjenju kornealnog slepila izazvanog nedostatkom vitamina A i malih boginja (5).

Prema preglednom radu koji je obuhvatio 40 različitih studija (6), prevalencija hiperopije (dalekovidosti) kod školske dece varira u zavisnosti od uzrasta: oko 8,4% kod šestogodišnjaka, opada na 2-3% kod dece u uzrastu od 9 do 14 godina, i približno 1% kod petnaestogodišnjaka. Ovo istraživanje takođe pokazuje da starost ima obrnuti odnos sa prevalencijom hiperopije, što znači da je učestalost ove refraktivne greške manja kako deca rastu. Hipermetropija je češća kod dece bele rase i onih koji žive u ruralnim područjima. Međutim, studije nisu identifikovale jasnu povezanost između hipermetropije i pola, prihoda porodice ili obrazovanja roditelja (6). Uzroci gubitka vida kod dece uključuju neispravljene refraktivne greške, kataraktu, retinopatiju nedonoščadi, urođene anomalije oka, ožiljke na rožnjači i cerebralne vizuelne poremećaje (7-9). Refraktivne greške, naročito miopija, predstavljaju vodeći i sve češći uzrok oštećenja vida i slepila kod dece (8,9). Prevalencija miopije kod dece i adolescenata brzo raste u mnogim delovima sveta. Ovaj nagli porast kratkovidosti sugeriše da, osim genetskih faktora, i okruženje igra važnu ulogu u razvoju oka i nastanku miopije (6,7). U 2020. godini, miopija je bila prisutna kod 60% dece u Aziji i 40% dece u Evropi (10,11). Procene ukazuju da je čak 40% slučajeva slepila kod dece moglo biti sprečeno ili adekvatno kontrolisano da su imali pristup pravovremenoj oftalmološkoj nezi (12). Oštećenje vida kod dece može ozbiljno uticati na obrazovne rezultate (3), doprineti niskom samopouzdanju (3) i smanjenju socijalno-ekonomskog potencijala u budućnosti (3). Prema izveštaju Komisije za globalno zdravlje očiju iz *The Lancet*-a, deca sa gubitkom vida u zemljama sa niskim i srednjim prihodima imaju do pet puta manju verovatnoću da budu uključena u formalno obrazovanje (7,13). *Malik* i saradnici su istakli da slepa deca imaju veću verovatnoću da umru tokom detinjstva u poređenju sa decom sa dobrim vidom, posebno u zemljama sa niskim prihodima (14).

Za poboljšanje zdravlja očiju kod dece i smanjenje invaliditeta, neophodne su sveobuhvatne usluge na svim nivoima zdravstvene zaštite (5). Prema izveštaju *Lancet* Komisije, nošenje naočara predstavlja jednu od najefikasnijih intervencija za očuvanje zdravlja očiju kod dece, jer može smanjiti verovatnoću ponavljanja razreda za 44% (7,12). Programi koji se fokusiraju na zdravlje vida u školama nude efikasan i isplativ model za preventivne mere i pravovremenu dijagnostiku refrakcionih grešaka kod školske dece (15-19).

Cilj ovog preglednog rada je da analizira rezultate različitih istraživanja u oblasti ranog otkrivanja i efikasnog upravljanja refrakcionim anomalijama kod dece i adolescenata u cilju smanjivanja invaliditeta i unapređenja zdravlja očiju kod dece.

Metode

U ovom preglednom radu izvršena je pretraga elektronske baze podataka PubMed koristeći sledeće ključne reči: „deca“, „refraktivne greške“, „prevencija“, „oftalmologija“ i „skrining“. Pretraga je obuhvatila radove objavljene u poslednjih deset godina. Analizirani su samo radovi koji su bili napisani na engleskom jeziku.

Rano otkrivanje (skrining) vizuelnih poremećaja

Vizuelni poremećaji mogu imati ozbiljne i dugoročne posledice na fizički, mentalni i socijalni razvoj deteta. Ovi poremećaji nastaju kada bolest oka ošteti vizuelni sistem, a klasifikuju se prema oštrini vida. U oftalmologiji, oštrina vida se meri pomoću različitih sistema. U Sjedinjenim Američkim Državama, najčešće korišćen sistem je „20/20”, koji označava standardnu vizuelnu oštrinu kojom osoba može videti objekat sa udaljenosti od 20 stopa, što je smatrano kao normalna oštrina vida (20). Sa druge strane, u mnogim drugim evropskim zemljama koristi se decimalni sistem za merenje oštrine vida (21-22). U ovom sistemu, oštrina vida se izražava decimalnim brojevima, gde je vrednost 1,0 (ili 100%) ekvivaabout 90 million children and adolescents live with varying degrees of vision loss. This group includes 2 million blind children, 30 million with moderate to severe visual impairment, and 58 million with mild vision loss (3). It is important to note that these figures cannot be summed, as they represent different categories, and there is no precise data on the overlap between children with refractive anomalies and those with vision loss due to other causes (3,4). The prevalence of vision loss in children varies significantly within and between countries and regions, but a general reduction in childhood blindness has been observed in all regions, particularly due to the decrease in corneal blindness caused by vitamin A deficiency and measles (5).

According to a review of 40 different studies (6), the prevalence of hyperopia (farsightedness) among school children varies by age: approximately 8.4% of six-year-olds, dropping to 2-3% in children aged 9 to 14, and around 1% in 15-year-olds. The study also indicates an inverse relationship between age and the prevalence of hyperopia, meaning that the incidence of this refractive error decreases as children grow. Hypermetropia is more common among white children and those living in rural areas. However, the studies did not identify a clear association between hypermetropia and gender, family income, or parental education (6). Causes of vision loss in children include uncorrected refractive errors, cataracts, retinopathy of prematurity, congenital eye anomalies, corneal scarring, and cerebral visual disorders (7-9). Refractive errors, particularly myopia, are the leading and increasingly common cause of visual impairment and blindness in children (8,9). The prevalence of myopia in children and adolescents is rising rapidly in many parts of the world. This rapid increase of myopia suggests that, in addition to genetic factors, the environment plays a significant role in eye development and the onset of myopia (6,7). In 2020, myopia was present in 60% of children in Asia and 40% of children in Europe (10,11). Estimates suggest that up to 40% of childhood blindness cases could have been prevented or adequately controlled if timely ophthalmological care had been accessible (12). Vision impairment in children can severely impact educational outcomes (3), contribute to low self-esteem (3), and reduce future socio-economic potential (3). According to the Lancet Global Commission report on Global Eye Health, children with vision loss in low- and middle-income countries are up to five times less likely to be enrolled in formal education (7,13). Malik and colleagues highlighted that blind children have a higher likelihood of dying during childhood compared to children with good vision, especially in low-income countries (14).

Comprehensive services at all levels of healthcare are essential for improving children's eye health and reducing disability (5). According to The Lancet Commission report, wearing glasses is one of the most effective interventions for preserving children's eye health, as it can reduce the likelihood of grade repetition by 44% (7,12). School-based vision health programs offer an efficient and cost-effective model for preventive measures and timely diagnosis of refractive errors in school children (15-19).

The aim of this review paper is to analyze the results of various studies on the early detection and effective management of refractive anomalies in children and adolescents, with the goal of reducing disability and improving eye health in children.

Methods

This review paper involved a search of the electronic database PubMed using the following keywords: “children,” “refractive errors,” “prevention,” “ophthalmology,” and “screening.” The search included studies published in the past ten years. Only articles written in English were analyzed.

Early detection (screening) of visual impairments

Visual impairments can have serious and long-term consequences for a child's physical, mental, and social development. These impairments occur when eye disease damages the visual system and are classified based on visual acuity. In ophthalmology, visual acuity is measured using different systems. In the United States, the most commonly used system is "20/20," which denotes standard visual acuity, where a person can see an object from a distance of 20 feet, which is considered normal visual acuity (20). In contrast, many other European countries use a decimal system for measuring visual acuity (21-22). In this system, visual acuity is expressed as

Tabela 1. Prilagođene metode skrininga vida kod dece i kriterijumi za dalju dijagnostiku

Metod	Indikacije za uput	Preporučena Starost
Test crvenog refleksa	Odsutan, beo, mutan, neproziran ili asimetričan refleks. Ovaj test pomaže u otkrivanju ozbiljnih problema kao što su katarakte ili retinoblastom.	Novorođenče – 6 meseci
Spoljni pregled	Prisutne strukturne abnormalnosti kao što je ptoza (opadanje kapka) koje mogu uticati na vid.	Novorođenče – 6 meseci
Pregled zenica	Nepravilan oblik, nejednaka veličina, loša ili neujednačena reakcija na svetlo.	Novorođenče – 6 meseci
Fiksacija i praćenje	Nemogućnost fiksacije (usmeravanje očiju ka objektu) i praćenje pokreta objekta.	Saradljivo dete ≥3 meseca
Refleks svetla sa rožnjače	Asimetričan ili pomeren refleks svetlosti može ukazivati na poremećaje u rožnjači ili drugim delovima oka.	Saradljivo dete ≥3 meseca
Instrumentalni skrining	Nemogućnost ispunjavanja kriterijuma skrininga može ukazivati na probleme sa vidom koji zahtevaju dodatnu evaluaciju.	Saradljivo dete ≥6 meseci
Cover test	Refiksacioni pokret nepokrivenog oka može ukazivati na probleme sa vidom kao što je strabizam (razrokost)	Saradljivo dete ≥6 meseci
Vid na daljinu (monokularno)	Lošija od 20/50 na bilo kojem oku ili razlika od 2 reda na optotipu između očiju može ukazivati na značajne probleme sa vidom koji zahtevaju dalje ispitivanje.	Saradljivo dete ≥6 meseci
Vid na daljinu (monokularno)	Lošija od 20/40 na bilo kojem oku ili razlika od 2 reda između očiju takođe može ukazivati na poteškoće koje treba dodatno ispitati.	Saradljivo dete ≥6 meseci

Izvor: Hagan JF, Shaw JS, Duncan PM, eds. 2017, Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents. 4th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2017.)

NAPOMENA: Preporuke su zasnovane na konsenzusu stručnjaka. U slučaju da skrining ne daje konačne ili zadovoljavajuće rezultate, dete bi trebalo ponovo testirati u roku od šest meseci. Ako ni ponovljeno testiranje nije konačno ili se ne može sprovesti, preporučuje se upućivanje na sveobuhvatan oftalmološki pregled. Subjektivno testiranje vidne oštrine se preferira kod dece koja mogu pouzdano učestvovati, dok je instrumentalni skrining koristan za mlađu decu i decu sa razvojnim poteškoćama. Preferirani optotipovi su LEA Simboli, HOTV, i Sloan Slova.

lentna normalnoj oštrini vida. Ova metoda omogućava lakše poređenje i interpretaciju rezultata oštrine vida u evropskim standardima. Jedinice mere (20/400, 20/200, 20/40, 20/20) koriste se za kvantifikaciju oštrine vida i omogućavaju preciznu klasifikaciju stepena slabovidosti. Prema definiciji Svetske zdravstvene organizacije (22) slabovidost se definiše na osnovu intenziteta na:

a) Slabovidost visokog intenziteta: Vizuelna oštrina u najboljem oku je manja od 20/400. Ovo stanje se često smatra slepilom, jer osoba sa ovim stepenom oštećenja vida može videti samo velike predmete iz vrlo bliske udaljenosti.

b) Slabovidost srednjeg intenziteta: Vizuelna oštrina varira između 20/200 i 20/400. Osobe sa ovim stepenom slabovidosti mogu prepoznati oblike i boje, ali imaju značajne poteškoće u svakodnevnim aktivnostima i čitanju.

c) Slabovidost niskog intenziteta: Vizuelna oštrina je između 20/40 i 20/200. Osobe sa ovim stepenom slabovidosti obično mogu obavljati većinu svakodnevnih aktivnosti uz pomoć korektivnih pomagala, ali i dalje imaju poteškoće u vidu na daljinu i u vidu u uslovima slabog osvetljenja.

Iako se istraživanja često fokusiraju na stariju populaciju, podaci o prevalenciji i uzrocima slabovidosti kod dece su ograničeni i verovatno potcenjeni. Slabovidost i slepilo su različita stanja. Slabovidost je češće i često se može značajno poboljšati rehabilitacijom, dok slepilo zahteva specijalizovane metode prilagođavanja i obrazovanja. Deca sa slabovidostima različitih intenziteta suočavaju se sa izazovima u obrazovanju, socijalizaciji i svakodnevnim aktivnostima (23). Naočare i kontaktna sočiva predstavljaju osnovne metode za korekciju refraktivnih grešaka kao što su miopija, hipermetropija i astigmatizam (24). Ortokeratologija, koja koristi specijalizovana kontaktna sočiva koja se nose tokom noći, može pružiti privremeno poboljšanje vida tokom dana (25,26). U okviru reha-

Table 1. Adapted vision screening methods for children and criteria for further diagnosis

Method	Indications for referral	Recommended age
Red Reflex Test	Absence, white, cloudy, opaque, or asymmetric reflex. This test helps detect serious issues such as cataracts or retinoblastoma.	Newborn – 6 months
External Examination	Presence of structural abnormalities such as ptosis (drooping eyelid) that may affect vision.	Newborn – 6 months
Pupil Examination	Irregular shape, unequal size, poor or uneven reaction to light.	Newborn – 6 months
Fixation and Tracking	Inability to fixate (direct eyes towards an object) and track object movements.	Cooperative child ≥3 months
Corneal Light Reflex	Asymmetric or displaced light reflex may indicate corneal or other eye disorders.	Cooperative child ≥3 months
Instrumental Screening	Failure to meet screening criteria may indicate vision problems requiring further evaluation.	Cooperative child ≥6 months
Cover Test	Refixation movement of the uncovered eye may indicate vision problems such as strabismus (squint).	Cooperative child ≥6 months
Distance Vision (Monocular)	Worse than 20/50 in either eye or a 2-line difference on the optotype between eyes may indicate significant vision problems requiring further investigation.	Cooperative child ≥6 months
Distance Vision (Monocular)	Worse than 20/40 in either eye or a 2-line difference between eyes may also indicate issues that need further examination.	Cooperative child ≥6 months

Source: Hagan JF, Shaw JS, Duncan PM, eds. 2017, Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents. 4th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2017.)

NOTE: Recommendations are based on expert consensus. If screening does not yield conclusive or satisfactory results, the child should be retested within six months. If repeated testing is still inconclusive or not feasible, a comprehensive ophthalmological examination is recommended. Subjective visual acuity testing is preferred for children who can reliably participate, while instrumental screening is useful for younger children and those with developmental difficulties. Preferred optotypes are LEA Symbols, HOTV, and Sloan Letters.

decimal numbers, where a value of 1.0 (or 100%) is equivalent to normal visual acuity. This method allows for easier comparison and interpretation of visual acuity results according to European standards. Units of measure (20/400, 20/200, 20/40, 20/20) are used to quantify visual acuity and allow for precise classification of degrees of visual impairment. According to the World Health Organization (22), visual impairment is defined based on intensity as follows: a) High-intensity visual impairment: Visual acuity in the better eye is less than 20/400. This condition is often considered blindness, as individuals with this level of vision loss can only see large objects from a very close distance. b) Medium-intensity visual impairment: Visual acuity ranges between 20/200 and 20/400. Individuals with this degree of visual impairment can recognize shapes and colors but have significant difficulties with daily activities and reading. c) Low-intensity visual impairment: Visual acuity is between 20/40 and 20/200. Individuals with this level of visual impairment can usually perform most daily activities with the aid of corrective devices but still have difficulties with distance vision and vision in low-light conditions.

Although research often focuses on older populations, data on the prevalence and causes of visual impairment in children are limited and likely underestimated. Visual impairment and blindness are distinct conditions. Visual impairment is more common and can often be significantly improved with rehabilitation, while blindness requires specialized adaptation and education methods. Children with visual impairments of varying degrees face challenges in education, socialization, and daily activities (23). Eyeglasses and contact lenses are fundamental methods for correcting refractive errors such as myopia, hypermetropia, and astigmatism (24). Orthokeratology, which uses specialized contact lenses worn overnight, can provide temporary vision improvement during the day (25,26). As part of rehabilitation, visual bilitacije, vizuelni programi fokusirani na vežbe za poboljšanje vizuelnih veština i tehnike za prilagođavanje svakodnevnim aktivnostima mogu značajno unaprediti preostale vizuelne sposobnosti (27). Pomoćne tehnologije, kao što su magnifikatori i specijalizovani računarski programi, takođe igraju važnu ulogu u obavljanju svakodnevnih zadataka i poboljšanju vizuelnog iskustva (28,29).

S druge strane, slepilo zahteva posebne strategije za prilagođavanje koje uključuju obrazovanje i pomoćne tehnologije (30,31). Obrazovni programi specijalizovani za decu sa slepilom često uključuju učenje brajevog pisma, tehnike orijentacije i mobilnosti, kao i veštine za samostalno obavljanje svakodnevnih aktivnosti. Individualizovani obrazovni planovi mogu pomoći u zadovoljenju specifičnih potreba deteta, omogućavajući mu da maksimalno iskoristi svoje potencijale. U rehabilitaciji vida kod slabovide dece, tehnologija igra ključnu ulogu u unapređenju percepcije i funkcionalnih veština. Sistem *TechArm* (31) je razvijen kao inovativno tehnološko sredstvo za procenu i rehabilitaciju vizuelnih sposobnosti. Ovaj sistem pruža kvantitativnu procenu razvoja perceptivnih i funkcionalnih veština, koje su obično zavisne od vida, i integriše se u prilagođene programe obuke. *TechArm* omogućava jednosenzornu i multisenzornu stimulaciju, pomažući slabovidim osobama da treniraju sposobnost pravilnog interpretiranja ne-vizuelnih signala iz okoline. Posebno je prilagođen za veoma malu decu, kada je potencijal za rehabilitaciju maksimalan. Sistem je testiran na deci sa različitim stepenima oštećenja vida i pokazao je da je multisenzorna stimulacija, posebno audio-taktička, korisna kada je perceptivna preciznost niska (31).

Skrining vida kod dece predstavlja ključnu komponentu zdravstvenih programa, sa ciljem otkrivanja i tretiranja poremećaja kao što je ambliopija. Deca sa binokularnim refrakcionim anomalijama često će sama prijaviti problem sa vidom ili će biti identifikovana kroz ciljani nadzor unutar specifičnih zdravstvenih programa, kao što su pregledi novorođenčadi i dece. Nasuprot tome, deca sa jednostranim smanjenjem vida, posebno kada je prisutno od ranog uzrasta, često nisu svesna problema, što ambliopiju čini skrivenim rizikom koji može ostati neotkriven bez specijalizovanog skrininga (32). Ambliopija nosi značajan rizik od slepila u kasnijem životu, ukoliko dođe do gubitka vida na zdravom oku (33,34). Zbog toga je od suštinskog značaja da se ovakvi poremećaji otkriju u ranoj fazi kako bi se omogućila pravovremena intervencija. Osnovni principi populacionog skrininga nalažu da se ovaj proces sprovodi samo za poremećaje za koje postoje pouzdani testovi i efikasni tretmani. Nedavna istraživanja pokazuju da skrining vida dece i adolescenata kao deo populacionih zdravstvenih programa u zemljama sa visokim i srednjim prihodima, igra ključnu ulogu u smanjenju tereta ambliopije na javno zdravlje (21-27).

Ipak, pristupi skriningu variraju od zemlje do zemlje, pri čemu se neki programi fokusiraju na identifikaciju ambliopije, dok drugi ciljaju na otkrivanje „ambliogenih" faktora rizika (32-43). U različitim pristupima skriningu, ambliogeni faktori rizika koji se uzimaju u obzir mogu uključivati nepravilnosti u refrakcionim greškama, strabizam, prisusvo kongenitalne katarakte, poteškoće u percepciji dubine i kontrasta, probleme u praćenju pokreta i koordinaciji očiju. Jedan od ključnih faktora za uspeh skrining programa je njegova prihvatljivost među roditeljima i stirateljima. Visoke stope učešća u studijama ukazuju na to da je skrining proces za identifikaciju ambliopije generalno dobro prihvaćen. Međutim, svaki test nosi rizik od lažno pozitivnih ili lažno negativnih rezultata. Kada se skrining vida sprovodi u ranom uzrastu, može doći do većeg broja lažnih upućivanja, što znači da test može pogrešno sugerisati potrebu za dodatnim pregledima. Lažna upućivanja se odnose na situacije kada skrining test daje rezultate koji sugerišu da dete ima problem, iako nema. Ova situacija može nastati zbog nedostataka u samom testu, prirodnog razvoja vida kod dece koji se može razlikovati od očekivanog, ili grešaka tokom testa. Kao posledica, test može nepotrebno sugerisati dodatne preglede i izazvati brigu kod roditelja, iako dete zapravo nema stvarni problem sa vidom. Ovo je primećeno kod dece koja su sa tri godine bila dijagnostikovana sa ambliopijom, ali je njihov vid značajno poboljšan do pete godine. (32). Iako neuroplastičnost, sposobnost mozga da se prilagođava i menja tokom života, traje sve do odraslog doba, ključno je da se intervencije kod dece sa ambliopijom sprovedu pre nego što dete navrši 6-7 godina. Istraživanja pokazuju da rano otkrivanje i lečenje mogu značajno poboljšati vizuelni razvoj, naročito kod dece sa težim oblicima ambliopije (40). Pravovremena intervencija može omogućiti deci da dostignu svoj puni vizuelni potencijal i značajno poboljša njihovu vizuelnu funkciju.

programs focused on exercises to enhance visual skills and techniques for adapting to daily activities can significantly improve remaining visual abilities (27). Assistive technologies, such as magnifiers and specialized computer programs, also play a crucial role in performing daily tasks and enhancing the visual experience (28,29).

On the other hand, blindness requires specialized adaptation strategies that include education and assistive technologies (30,31). Educational programs tailored for blind children often involve learning Braille, orientation and mobility techniques, and skills for independently performing daily activities. Individualized educational plans can help address the specific needs of the child, allowing them to maximize their potential. In visual rehabilitation for visually impaired children, technology plays a crucial role in enhancing perception and functional skills. The TechArm system (31) has been developed as an innovative technological tool for assessing and rehabilitating visual abilities. This system provides a quantitative assessment of the development of perceptual and functional skills, which are usually dependent on vision, and integrates into customized training programs. TechArm enables both unisensory and multisensory stimulation, helping visually impaired individuals train their ability to interpret non-visual environmental signals. It is especially suited for very young children, when the potential for rehabilitation is highest. The system has been tested on children with varying degrees of vision impairment and has shown that multisensory stimulation, particularly audio-tactile, is beneficial when perceptual accuracy is low (31).

Vision screening in children is a crucial component of health programs, aimed at detecting and treating disorders such as amblyopia. Children with binocular refractive anomalies will often report vision problems themselves or be identified through targeted monitoring within specific health programs, such as newborn and child screenings. In contrast, children with unilateral vision loss, especially when present from an early age, are often unaware of the problem, making amblyopia a hidden risk that may remain undetected without specialized screening (32). Amblyopia carries a significant risk of blindness later in life if vision loss occurs in the healthy eye (33,34). Therefore, it is essential to detect such disorders at an early stage to enable timely intervention. The basic principles of population screening require that this process be implemented only for disorders for which reliable tests and effective treatments exist. Recent studies indicate that vision screening for children and adolescents as part of population health programs in high- and middle-income countries plays a key role in reducing the burden of amblyopia on public health (21-27).

However, screening approaches vary from country to country, with some programs focusing on identifying amblyopia, while others target the detection of "amblyogenic" risk factors (32-43). In different screening approaches, amblyogenic risk factors, which are taken into consideration, may include refractive errors, strabismus, presence of congenital cataracts, difficulties in depth and contrast perception, and problems with tracking movements and eye coordination. One key factor for the success of a screening program is its acceptability among parents and caregivers. High participation rates in studies suggest that the screening process for identifying amblyopia is generally well-received. However, every test carries the risk of false-positive or false-negative results. When vision screening is conducted at an early age, there may be a higher number of false referrals, meaning the test may incorrectly suggest the need for further evaluations. False referrals occur when a screening test yields results indicating that a child has a problem, even though they do not. This situation may arise due to deficiencies in the test itself, natural variations in visual development among children that may differ from expectations, or errors during the test. As a result, the test may unnecessarily suggest additional evaluations and cause undue concern for parents, even if the child does not actually have a vision problem. This has been observed in children diagnosed with amblyopia at the age of three, whose vision significantly improved by the age of five (32). Although neuroplasticity, the brain's ability to adapt and change throughout life, continues into adulthood, it is crucial that interventions for amblyopia in children be carried out before the child reaches 6-7 years of age. Research shows that early detection and treatment can significantly improve visual development, particularly in children with severe forms of amblyopia (40). Timely intervention can enable children to reach their full visual potential and significantly enhance their visual function.

U primarnim zdravstvenim ustanovama, školama i vrtićima, skrining vida se najčešće obavlja procenom oštrine vida, što je najbolja pojedinačna mera zdravlja očiju kod dece. Uprkos tome, deca koja ne prođu skrining oštrine vida obavljen u ovim ustanovama možda zapravo nemaju prave deficite u oštrini vida kada se procenjuju u oftalmološkoj klinici (28). Ova varijabilnost može biti rezultat više faktora, uključujući nedosledne tehnike ispitivača, uslove okoline (osvetljenje) i faktore vezane za pacijente (saradnja i razumevanje). Aktuelne smernice Američke akademije za pedijatriju (AAP) (44), ažurirane 2016. godine, navode da skrining oštrine vida „zahteva da dete tačno odgovori na većinu optotipova prisutnih na kritičnoj liniji". „Kritična linija" označava najmanje detalje koje dete treba da bude sposobno da vidi kako bi se smatralo da ima normalnu oštrinu vida za svoj uzrast. Jedinice mere predstavljaju sposobnost oka da razlikuje detalje na određenim udaljenostima i obično se izražavaju kao odnosi, kao što su 20/50, 20/40, i 20/32. Prva brojka označava udaljenost na kojoj je osoba testirana (u ovom slučaju 20 stopa). Druga brojka označava udaljenost na kojoj bi osoba sa normalnom oštrinom vida mogla da vidi iste detalje. Prema smernicama AAP, očekivana oštrina vida kod dece je 20/50 za uzrast od 36 do 47 meseci, 20/40 za uzrast od 48 do 59 meseci, i 20/32 za uzrast od 60 meseci i više. U publikaciji Američkog udruženja za pedijatrijsku oftalmologiju i strabizam (AAPOS) iz 2013. godine (45) sugerisano je da otkrivanje ambliopije i smanjene oštrine vida koristeći optotip-zasnovani skrining treba da bude zasnovano na monokularnoj oštrini vida manjoj od 20/30 i da smernice za procenu nerefektivnih instrumenata za skrining vida treba da uključe analizu senzitivnosti za otkrivanje monokularne oštrine vida manje od 20/30, razliku od tri linije u intraokularnoj oštrini vida, i prisutni strabizam.

Više metoda se koristi u proceni oštrine vida kod dece. Tradicionalno, papirne tablice sa raznim optotipovima (Lea slike, obrnut „E", *Snellen*-ova slova) korišćene su za procenu oštrine vida na daljinu. Nije lako naterati malu decu da razumeju sadržaj testova za oštrinu vida. Na primer, može biti teško objasniti im ciljeve testova oštrine vida na Landoltovom prstenu ili *Snellen*-ovoj tablici. Postoje tablice za ispitivanje oštrine vida kod dece starosti 3-6 godina, koje koriste jednostavne simbole kao vizuelne ciljeve, ali potreba da se razume sam vizuelni cilj nije se promenila (28,32,33,35). Na primer, prilikom korišćenja slike kao vizuelnog cilja, deca moraju da razumeju šta sama slika predstavlja (npr. konj, automobil).

Nedavno su se pojavile alternativne metode koje bi mogle smanjiti varijabilnost u proceni oštrine vida. *Peek Acuity* je nova aplikacija za pametne telefone za procenu oštrine vida, koja koristi sistem obrnutog „E" sa dodatnim linijama koje omogućavaju skrining kod neverbalnih pacijenata koji ne razumeju engleski jezik (46). Iako je procena oštrine vida uz pomoć *Peek Acuity* aplikacije pokazala visoku korelaciju sa *Snellen*-ovim pregledom u odrasloj populaciji u Keniji (28), malo studija je procenilo njenu upotrebu kod dece. Sve prethodne studije koje su procenjivale *Peek Acuity* aplikacije kod dece sprovedene su u zemljama u razvoju među školskom decom i koristile su prag oštrine vida od 20/40 što označava granićnu vrednost ispod koje je potrebno dodatno ispitivanje (28,40). Ključni rezultati pokazali su da je procena oštrine vida pomoću *Peek Acuity* aplikacije u velikoj meri bila u skladu sa rezultatima dobijenim standardnim metodama, posebno kod dece starije od 5 godina. Kod predškolske dece (uzrasta 3 do 5 godina), aplikacija je pokazala visoku senzitivnost, ali su deca u ovoj grupi bila podložnija zamoru tokom pregleda (28).

U zemljama sa niskim i srednjim prihodima, najčešći uzroci oštećenja vida su poremećaji mrežnjače, glaukom kornealni ulkus izazvani nedostatkom vitamina A, i katarakta. U razvijenim zemljama, neurološki poremećaji su glavni uzrok oštećenja vida. Zdravstvene inicijative poput VISION 2020 (42) teže eliminaciji i prevenciji slepila kroz unapređenje oftalmoloških usluga i prevenciju. Studija sprovedena u Tuzli, Bosna i Hercegovina (36), obuhvatila je 7415 dece uzrasta od 4 do 15 godina u periodu od 2015. do 2019. godine. Rezultati su pokazali da je 145 dece imalo refraktivne greške, pri čemu je astigmatizam bio najčešća anomalija, prisutan u 52,4% slučajeva. Ova studija ističe potrebu za implementacijom programa skrininga vida u školama kako bi se omogućilo ranije otkrivanje i lečenje problema sa vidom. S druge strane, istraživanje iz Istočne i Jugoistočne Azije (29) naglašava ozbiljnost porasta miopije i njenih patoloških posledica, kao što su miopska makulopatija i optička neuropatija, koje su među najčešćim uzrocima nepovratnog slepila. Strategije za smanjenje prevalencije miopije uključuju povećanje vremena provedenog na ot-

In primary healthcare institutions, schools, and kindergartens, vision screening is most commonly performed by assessing visual acuity, which is the best single measure of eye health in children. Despite this, children who do not pass vision acuity screenings conducted in these institutions may actually have no true deficits in visual acuity when assessed in an ophthalmological clinic (28). This variability may result from several factors, including inconsistent examiner techniques, environmental conditions (lighting), and patient-related factors (cooperation and understanding). Current guidelines from the American Academy of Pediatrics (AAP) (44), which were updated in 2016, state that visual acuity screening "requires the child to correctly identify most optotypes on the critical line." The "critical line" represents the smallest detail a child should be able to see to be considered to have normal visual acuity for their age. Measurement units represent the eye's ability to distinguish details at specific distances and are usually expressed as ratios, such as 20/50, 20/40, and 20/32. The first number indicates the distance at which the person is tested (in this case, 20 feet). The second number indicates the distance at which a person with normal visual acuity would be able to see the same details. According to AAP guidelines, expected visual acuity in children is 20/50 for ages 36 to 47 months, 20/40 for ages 48 to 59 months, and 20/32 for ages 60 months and older. In a publication of the American Association for Pediatric Ophthalmology and Strabismus (AAPOS) in 2013 (45), it was suggested that the detection of amblyopia and reduced visual acuity using optotype-based screening should be based on monocular visual acuity less than 20/30 and that guidelines for evaluating non-refractive vision screening instruments should include sensitivity analysis for detecting monocular visual acuity less than 20/30, a three-line difference in intraocular visual acuity, and the presence of strabismus.

Several methods are used to assess visual acuity in children. Traditionally, paper charts with various optotypes (Lea symbols, the reversed "E", Snellen letters) have been used to measure distance visual acuity. It is not easy to make young children understand the content of visual acuity tests. For example, it can be difficult to explain the purpose of visual acuity tests using Landolt rings or Snellen charts. There are charts designed for testing visual acuity in children aged 3-6 years that use simple symbols as visual targets, but the need for the child to understand the visual target itself has not changed (28,32,33,35). For example, when using pictures as visual targets, children must understand what the picture represents (e.g., a horse, a car).

Recently, alternative methods have emerged that could reduce variability in visual acuity assessment. Peek Acuity is a new smartphone application for assessing visual acuity that uses a reversed "E" system with additional lines, allowing screening of non-verbal patients who do not understand English (46). Although the assessment of visual acuity using the Peek Acuity app has shown a high correlation with Snellen screening in the adult population in Kenya (28), few studies have evaluated its use in children. All previous studies evaluating the Peek Acuity app in children were conducted in developing countries among school-aged children and used a visual acuity threshold of 20/40, which indicates a borderline value below which further examination is needed (28,40). Key findings showed that the Peek Acuity app's visual acuity assessment was largely consistent with results obtained from standard methods, particularly in children older than 5 years. In preschool children (aged 3 to 5 years), the app demonstrated high sensitivity, but children in this group were more prone to fatigue during the examination (28).

In low- and middle-income countries, the most common causes of visual impairment are retinal disorders, glaucoma, corneal ulcers caused by vitamin A deficiency, and cataracts. In developed countries, neurological disorders are the leading cause of visual impairment. Health initiatives such as VISION 2020 (42) aim to eliminate and prevent blindness through the enhancement of ophthalmological services and prevention efforts. A study conducted in Tuzla, Bosnia and Herzegovina (36), covered 7,415 children aged 4 to 15 years from 2015 to 2019. The results showed that 145 children had refractive errors, with astigmatism being the most common anomaly, present in 52.4% of cases. This study highlights the need for implementing vision screening programs in schools to enable earlier detection and treatment of vision problems. On the other hand, research from East and Southeast Asia (29) underscores the severity of the increase in myopia and its pathological consequences, such as myopic maculopathy vorenom i korišćenje niskodoznih atropinskih kapi, multifokalnih sočiva i ortokeratologije. Istraživanje dugoročnih promena u miopiji kod školske dece u Kini (37), koja je obuhvatila 773 pacijenta, pokazuje da je prosečan stepen miopije značajno porastao tokom adolescencije, sa prosečnim sfernim ekvivalentom koji se povećao sa -1,92 dioptrije na -6,05 dioptrije do 16. godine. Deca kod kojih se miopija pojavila pre 10. godine imala su visok rizik za razvijanje visoke miopije u kasnijim godinama, što naglašava važnost ranog otkrivanja i praćenja ove refraktivne greške. Udaljene australijske regije sa ograničenim oftalmološkim uslugama pokazuju visoku prevalenciju neotkrivenih problema sa vidom, uključujući značajne refraktivne poremećaje i poremećaje binokularnog vida (38).

Pregled smernica za oftalmološke preglede dece i adolescenata

Smernice koje su razvile stručne organizacije, kao što su Američka akademija za oftalmologiju (AAO) i Američka akademija za pedijatriju (AAP), pružaju detaljna uputstva za oftalmološke preglede kod dece, uz poseban fokus na rizične grupe, kao što su prevremeno rođena deca ili deca sa porodičnom istorijom očnih bolesti (27,38,39). Ove smernice predstavljaju osnovu za preventivne i korektivne mere koje imaju za cilj očuvanje i unapređenje vizuelnog zdravlja od najranijeg uzrasta. Preporuke za oftalmološke preglede počinju od trenutka rođenja. Sva prevremeno rođena deca, posebno ona mlađa od 35 nedelja gestacije ili sa telesnom težinom manjom od 1500 grama, zahtevaju posebnu pažnju. Ova deca, zbog nezrelosti vizuelnog sistema, predstavljaju rizičnu grupu za razvoj različitih patoloških promena na očima, uključujući i ambliopiju. Takođe, deca rođena u terminu, kod kojih se ne može detektovati crveni refleks, zahtevaju ranu oftalmološku procenu. Sa šest meseci starosti, preporučuje se pregled za decu kod koje je prisutna razrokost, dok sa napunjenih godinu dana, posebna pažnja treba da se posveti deci sa porodičnom istorijom ozbiljnih očnih bolesti, slabovidosti ili razrokosti. Deca čiji roditelji imaju izražene refraktivne greške, kao što su velika kratkovidost ili dalekovidost, ili razlika u dioptriji od 1D između očiju, takođe spadaju u rizičnu grupu i zahtevaju pažljivo praćenje. Između druge i četvrte godine života, svi mališani treba da prođu kroz oftalmološki pregled kako bi se identifikovali eventualni problemi sa vidom pre polaska u školu, kada vizuelna funkcija postaje kritična za razvoj i učenje. U kasnijem uzrastu, dalji pregledi se planiraju u skladu sa prethodnim nalazima, u dogovoru sa oftalmologom.

Ambliopija, kao jedan od najčešćih problema u dečijem uzrastu, ispunjava kriterijume Svetske zdravstvene organizacije za bolesti koje zahtevaju skrining. Ambliopija je zdravstveni problem od velike važnosti jer postoje prihvaćeni tretmani koji mogu sprečiti trajni gubitak vida, ukoliko se otkrije na vreme. Prepoznatljivost latentnog ili ranog simptomatskog stadijuma ove bolesti, kao i dostupnost testova za njeno rano otkrivanje, čine je pogodnom za redovni skrining. Američka radna grupa za preventivne usluge (USPSTF) preporučuje skrining vida za svu decu uzrasta od 3 do 5 godina, bar jednom, kako bi se otkrila ambliopija ili faktori rizika za njeno nastajanje (refraktivnih grešaka, kongenitalne katarakte, ptosisa, retiopatije, genetskih faktora). Testiranje vida sa pojedinačnim optotipima može dovesti do precenjenog rezultata oštrine vida kod dece sa ambliopijom. Zato se tačnija procena monokularne oštrine vida postiže korišćenjem niza optotipova (12,21,22,32,47,48). Optotipovi mogu biti u obliku slova, brojeva ili simbola poput "C" i "E". Ovi simboli su postavljeni na tabelama različitih veličina. Na tabeli, simboli su različitih veličina, koje postaju sve manje kako se krećemo prema dnu tabele. Manji simboli predstavljaju bolje oštrinu vida, dok veći simboli predstavljaju lošiju oštrinu. Izbor i raspored optotipova na tablici za određivanje vizuelne oštrine imaju značajan uticaj na rezultate merenja. Svaka linija ili naredni red znakova, simbola ili slova na optotipu označava određeni nivo vidne oštrine, gde je svaka naredna linija sitnija i predstavlja viši nivo oštrine vida. Standardizovani optotipovi (48), kao što su LEA simboli (jednostavni piktogrami, krst, kvadrat, polukrug, krug, prilagođeni mlađoj deci i deci koja ne znaju da čitaju) (HOTV (specifična slova visokog kontrasta odabrana zbog svoje prepoznatljivosti i jednostavnosti H, O, T, i V, što pomaže u preciznom merenju oštrine vida kod dece) i Sloan slova (standardizovana slova koja se koriste za precizno merenje oštrine vida kod svih uzrasta) pružaju validne i pouzdane rezultate, čime se osigurava tačnost dijagnostičkog procesa.

Tehnike skrininga koje se baziraju na instrumentima, kao što su fotoskrining i autorefrakcija, posebno su korisne za detekciju faktora rizika za ambliopiju kod dece uzrasta od 1 do 5 godina, and optical neuropathy, which are among the most common causes of irreversible blindness. Strategies for reducing the prevalence of myopia include increasing time spent outdoors and using low-dose atropine drops, multifocal lenses, and orthokeratology. A study on long-term changes in myopia among school children in China (37), which included 773 patients, showed that the average degree of myopia significantly increased during adolescence, with the average spherical equivalent rising from -1.92 diopters to -6.05 diopters by age 16. Children who developed myopia before age 10 had a high risk of developing high myopia in later years, emphasizing the importance of early detection and monitoring of this refractive error. Remote Australian regions with limited ophthalmological services show a high prevalence of undetected vision problems, including significant refractive errors and binocular vision disorders (38).

Review of guidelines for pediatric and adolescent ophthalmological examinations

Guidelines developed by professional organizations such as the American Academy of Ophthalmology (AAO) and the American Academy of Pediatrics (AAP) provide detailed instructions for ophthalmological examinations in children, with a special focus on high-risk groups such as premature infants or those with a family history of eye diseases (27,38,39). These guidelines form the basis for preventive and corrective measures aimed at preserving and improving visual health from the earliest age. Recommendations for ophthalmological examinations begin at birth. All premature infants, especially those born before 35 weeks of gestation or weighing less than 1500 grams, require special attention. Due to the immaturity of their visual systems, these infants are at risk for developing various pathological changes in the eyes, including amblyopia. Additionally, full-term infants who do not exhibit a red reflex also require early ophthalmological assessment. At six months of age, screening is recommended for children with strabismus, and at the age of one year, special attention should be given to children with a family history of serious eye diseases, visual impairment, or strabismus. Children whose parents have significant refractive errors, such as high myopia or hyperopia, or a difference in diopters of 1D between the eyes, are also considered at risk and require careful monitoring. Between the ages of two and four years, all children should undergo an ophthalmological examination to identify any vision problems before starting school, as visual function becomes critical for development and learning. In later years, further examinations should be planned based on previous findings, in consultation with an ophthalmologist.

Amblyopia, as one of the most common issues in childhood, meets the criteria set by the World Health Organization for diseases that require screening. Amblyopia is a significant health issue because accepted treatments can prevent permanent vision loss if detected early. The recognizability of the latent or early symptomatic stage of this condition, along with the availability of tests for early detection, makes it suitable for regular screening. The U.S. Preventive Services Task Force (USPSTF) recommends vision screening for all children aged 3 to 5 years at least once, to detect amblyopia or risk factors for its development (refractive errors, congenital cataracts, ptosis, retinopathy, genetic factors). Visual acuity testing with single optotypes may lead to an overestimated visual acuity result in children with amblyopia. Therefore, a more accurate assessment of monocular visual acuity is achieved using a series of optotypes (12,21,22,32,47,48). Optotypes may be in the form of letters, numbers, or symbols like "C" and "E". These symbols are presented on charts of varying sizes. On the chart, symbols decrease in size as you move down the chart. Smaller symbols represent better visual acuity, while larger symbols represent poorer visual acuity. The choice and arrangement of optotypes on the chart significantly impact measurement results. Each line or subsequent row of characters, symbols, or letters on the optotype represents a specific level of visual acuity, with each following line being finer and representing a higher level of visual acuity. Standardized optotypes (48), such as LEA symbols (simple pictograms like crosses, squares, semicircles, circles, tailored for younger children and those who cannot read), HOTV letters (high-contrast specific letters chosen for their recognizability and simplicity H, O, T, and V, which help in precise measurement of visual acuity in children), and Sloan letters (standardized letters used for precise visual acuity measurement across all ages) provide valid and reliable results, ensuring accuracy in the diagnostic process.

što je kritičan period za razvoj vizuelnog sistema (Tabela 1). Ove metode su takođe primenljive i kod starije dece koja nisu u mogućnosti da učestvuju u standardnom skriningu zasnovanom na optotipovima, kao i kod dece sa razvojnim poteškoćama. Skrining zasnovan na instrumentima pokazao je visoku efikasnost u detekciji faktora rizika za ambliopiju i kod ove populacije. Skrining vida treba da bude redovan deo zdravstvene zaštite dece, pri čemu elementi skrininga variraju u zavisnosti od uzrasta i nivoa saradnje deteta, kako bi se na vreme identifikovali i lečili problemi sa vidom koji mogu imati dugoročne posledice na detetov razvoj i kvalitet života.

Zaključak

Rani vizuelni problemi mogu imati dugotrajne posledice po dečji razvoj, zbog čega je neophodno uspostaviti standardizovane protokole pregleda. Rani skrining može pomoći u identifikaciji problema poput ambliopije i refraktivnih grešaka, koje mogu imati dugoročne posledice razvoj dece i aolescenata. Uvođenje smernica razvijenih od strane stručnih organizacija, poput Američke akademije za oftalmologiju i Američke akademije za pedijatriju, pruža okvir za optimalnu pedijatrijsku oftalmološku praksu i može značajno doprineti smanjenju prevalencije ovih problema. Skrining prilagođen uzrastu deteta, od novorođenčadi do starije dece, a posebno je važan u uzrastu od 6 meseci do 5 godina, kada se dečji vid intenzivno razvija, osigurava ranu detekciju problema, što omogućava pravovremeno intervenciono lečenje i smanjenje dugoročnih posledica na razvoj. Pravovremena implementacija ovih skrininga ne samo da poboljšava vizuelno zdravlje, već pozitivno utiče na opšti razvoj i kvalitet života dece. Iako je napredak postignut, neophodno je nastaviti sa istraživanjima i edukacijom, kako bi se osigurali najbolji mogući ishodi za najmlađu populaciju.

Konflikt interesa

Autori su izjavili da nema konflikta interesa.

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Instrument-based screening techniques, such as photoscreening and autorefractors, are especially useful for detecting risk factors for amblyopia in children aged 1 to 5 years, which is a critical period for visual system development (Table 1). These methods are also applicable to older children who cannot participate in standard optotype-based screening, as well as children with developmental disabilities. Instrument-based screening has shown high efficacy in detecting risk factors for amblyopia in this population. Vision screening should be a regular part of children's health care, with screening elements varying based on age and the child's level of cooperation, so as to identify and address vision problems that may have long-term effects on the child's development and quality of life.

Conclusion

Early visual problems can have long-lasting effects on child development, due to which the establishment of standardized screening protocols is essential. Early screening can help identify issues such as amblyopia and refractive errors, which can have long-term consequences on the development of children and adolescents. Implementing guidelines developed by professional organizations, such as the American Academy of Ophthalmology and the American Academy of Pediatrics, provides a framework for optimal pediatric ophthalmological practice and can significantly contribute to reducing the prevalence of these issues. Age-appropriate screening, from infancy to older children, especially between 6 months and 5 years of age when visual development is intensive, ensures early detection of problems, allowing timely intervention and reduction of long-term developmental impacts. Timely implementation of these screenings not only improves visual health but also positively affects overall child development and their quality of life. Although progress has been made, continued research and education are necessary to ensure the best possible outcomes for the youngest population.

Competing interests

The authors declared no competing interests.

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