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Poverty and Vision: The Effect of Title 1 Status on Vision Screening Referral Rates in School-Aged Children in Western South Dakota

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ABSTRACT

***Purpose*:** Interventions such as eye exams and glasses are used to correct visual problems that may lead to amblyopia, an irreversible decrease in visual acuity. Children with limited access to these interventions are more likely to have unaddressed visual problems that can lead to amblyopia or negatively impact school performance. This study compared vision screening results of children in schools with Title 1 or Non-Title 1 designation to investigate the link between poverty and vision.

***Methods*:** Data from KidsFIRST vision screenings conducted with the SPOT^{TM} photoscreener performed in Rapid City Area elementary schools were compared across multiple parameters. Students were referred for eye examinations based on identifying the following problems: anisometropia, anisocoria, astigmatism, myopia, hyperopia, gaze misalignment, or a combination.

***Results*:** Overall, eye exam referral rates have increased since 2012 (11.9% in 2012, 19.7% in 2023), with a disproportionate increase in referrals from Title 1 schools (25.2% in 2023) vs. Non-Title 1 schools (11.9% in 2023) ($p < 0.001$). This is largely due to a significantly higher prevalence of astigmatism referrals in Title 1 students (20.9%) compared to Non-Title 1 students (7.5%). Although a higher percentage of Title 1 students are reported to have eye correction (24.4% vs 16.6%), only a slightly higher percentage of Title 1 students wore eye correction during screening (11.5% vs 10.5%).

***Conclusion*:** Students at Title 1 schools may have a higher rate of amblyopia risk factors. Additional eye care-based interventions should be taken to reduce the risk of amblyopia in this population.

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Introduction

Vision screening in children is essential to prevent vision-threatening conditions. Eye problems unaddressed during a child's neurological development can lead to permanent vision loss known as amblyopia. Defined as a unilateral or bilateral decrease in vision occurring during early development that is not attributed to anatomical problems, amblyopia is most commonly caused by strabismus or uncorrected asymmetric refractive errors.[1] The risk of progressing to amblyopia is greatly reduced by addressing visual problems before full visual pathway development occurs.[2] Population studies estimate the prevalence of amblyopia to be between 2% and 5%, but as many as 21% of children have risk factors for vision disorders.[3,4] Early childhood vision screening is associated with a 70% lower prevalence of amblyopia.[5] Although early intervention is preferable, children with uncorrected vision problems past the age of visual pathway development may still benefit from vision screening by achieving improved school performance and standardized test scores.[6–10] With 75% of children's vision problems being discovered at school screenings and not healthcare facilities, it is critical screening programs target the highest proportion of children as early as possible.[11]

Despite the importance of early vision screening, South Dakota remains one of eight states lacking a formal childhood vision screening policy.[12] This is true despite the U.S. Preventive Services Task Force recommendation for vision screening to be performed at least once in all children aged 3–5 years to detect amblyopia or amblyopia risk factors.[13] While screening for amblyopia is considered to be most crucial at this young age, AAPOS guidelines for instrument-based vision screening recommend addressing uncorrected refractive error and myopia in all school-aged children. These recommendations are critical because although children over the age of four have a lower risk of amblyopia development, unaddressed visual disorders can still adversely impact school performance.[6,9,10]

It is well known that socioeconomic factors play a role in an individual's overall health, including vision. Children from lower socioeconomic statuses are at an increased risk of having undiagnosed visual problems,[14]

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often correlating with uncorrected amblyopia risk factors.[15,16] Title 1 is a U.S. federal education program that distributes funds to schools that have at least a 40% student population from low-income households, with the goal of bridging gaps between communities of varying socioeconomic statuses. Previous research indicates Title 1 students may be 2–3 times more likely to have unaddressed vision problems compared to their counterparts.[17] A recent, large cross-sectional survey found children from low-income households are less likely to be screened and more likely to be referred for eye examinations.[18] However, further research is needed to identify and overcome barriers to vision screening in children, with the goal of increasing screening rates among those most at risk. Our study aims to evaluate the relationship between Title 1 status and vision screening referrals, offering solutions to enhance screening programs and reduce disparities in eye care within this population.

Methods

The University of South Dakota Institutional Review Board gave approval for the completion of this research which adheres to the guidelines of the Declaration of Helsinki. Data utilized for this study were provided by LifeSight, a Rapid City based 501(c)(3) nonprofit organization. Since 2012, LifeSight operates the KidsFIRST Free Vision Screening program, which has administered over 55,000 free vision screenings to school-aged children.

KidsFIRST vision screening results utilizing the SPOT^{TM} photoscreener (PediaVision, Welch Allyn, Skaneateles Falls, NY) administered in Rapid City Area elementary schools during the 2021–2022 and 2022–2023 school years were compared. All data were collected from vision screenings administered by LifeSight staff and trained volunteers. Referral criteria were based on the configurable threshold settings established by the SPOT^{TM} distributor Baxter beyond Welch Allen, which has remained constant since the screening program began. The SPOT^{TM} photoscreener does not allow for easy adjustment of referral criteria to improve false positive rates, therefore referral rates should be similar over the years studied. Additionally, LifeSight staff elected to maintain referral criteria and threshold settings over the course of the years for which screening was performed to maintain consistency for study. The most current SPOT software versions of 3.1.01.00-A0002 (2021–2022) and 3.1.01.00-A0001 (2022–2023) were utilized. Historic KidsFIRST vision screening data from 2012 through 2020–2021 were also included for some analysis. Data collected included school, Title 1 status, number of children screened and referred for eye exam, reason for referral, whether a child was wearing appropriate corrective lenses if needed, gender, and age.

Prior to screening, parents/guardians indicated whether their child normally wore glasses or contacts, which was entered into the software. If the child wore corrective eyewear, the SPOT^{TM} adjusted for the prescription and screened through the correction and compared to a threshold setting to determine the need for a referral. If the child should be wearing correction but does not have it with them, the procedure is to still administer the screening. The parent/guardian is then informed about their screening results indicating the child did not wear their correction, along with information about the importance of their child wearing correction regularly.

As part of the Rapid City new online school registration process for the 2021–2022 school year, parents/guardians checked "Yes" or "No" to provide consent for their child to receive a free vision screening. Only children whose consent was obtained were administered a screening. Prior to 2021–2022, vision screenings were available to students in preschool, kindergarten, first, third, and fifth, provided the parent/guardian completed a paper document titled "Free Vision Screening Consent Form".

Results

Overview

From 2012 to 2023, a total of 32,384 vision screenings have been completed within Rapid City elementary schools with a total of 4,615 eye exams being recommended. Since 2012, the combined eye exam referral rate for all schools was 14.3%. Referral rate was 18.2% for Title 1 schools and 8.9% for Non-Title 1 schools ($p < 0.001$).

Demographics

An increase in vision screenings led to 9,562 vision screenings being administered during the 2021–2022 and 2022–2023 school years, corresponding to 1,841 eye exam referrals (19.3% referral rate). From 2021 to 2023, Title 1 schools made up 58.2% of screenings ($n = 5,568$) with males making up 51.9% ($n = 4,963$) of screenings. For all schools from 2021 to 2023 (Title 1 and Non-Title 1), 1.5% ($n = 140$) of the children were in preschool, 20.4% ($n = 1,947$) kindergarten, 17.4% ($n = 1,661$) first grade, 13.6% ($n = 1,299$) second grade, 16.5% ($n = 1,581$) third grade, 14.5% ($n = 1,385$) fourth grade, and

16.2% ($n = 1,549$) fifth grade. The average age of the children screened from 2021 to 2023 was 92 months (7.6 years).

Title 1 and Non-Title 1 comparisons

For the 2021–2023 school years, which correlate with the increased vision screening numbers via the change to online registration and electronic consent, the overall eye exam referral rate was 19.3% ($n = 1,841$), with Title 1 schools being 24.9% ($n = 1,384$) and Non-Title 1 schools 11.4% ($n = 457$) [Table 1]. Title 1 schools were associated with a significantly higher referral rate ($p < 0.001$) compared to Non-Title 1 schools.

Registration type comparisons

Referral rate following the change to online registration (2021–2023: 19.3%) was found to be significantly higher compared to pre-online registration years (2012–2020: 12.3%) ($p < 0.001$). This significance was maintained when just evaluating Title 1 schools and Non-Title 1 schools separately (both $p < 0.001$).

Table 1. Total percentages of children referred for comprehensive eye exam following SPOT™ photoscreener vision screening at Rapid City area elementary schools.

Year	Children Screened	Total % Referred (All Schools)	Title 1% Referred	Non-Title 1% Referred
2012–13	966	11.39%	16.30%	6.70%
2013–14	1993	12.90%	15.50%	8.30%
2014–15	2312	11.29%	13.20%	8.70%
2015–16	2821	9.36%	11.60%	6.30%
2016–17	2826	9.52%	11.60%	7%
2017–18	3232	11.70%	15%	7.70%
2018–19	3456	12.21%	16.10%	7%
2019–20	2725	13.21%	17.30%	8.20%
2020–21	2491	18.19%	22.10%	12.40%
2021–22	4599	18.81%	24.50%	10.90%
2022–23	4,963	19.67%	25.20%	11.90%
Totals	**32384**	**14.25%**	**18.19%**	**8.89%**

Table 2. Reasons for eye exam referral broken down for title 1 vs non-title 1 schools for the 2021–2023 school years. The sum of all reasons for referrals is greater than the total number of referrals due to many children being referred for multiple risk factors.

Reason for Referral	Title 1 Schools	Non-Title 1 Schools	Totals (All Schools)
Astigmatism	1166 (20.9%)	300 (7.5%)	1466 (15.3%)
Hyperopia	58 (1.0%)	28 (0.7%)	86 (0.9%)
Myopia	257 (4.6%)	90 (2.3%)	347 (3.6%)
Misalignment	69 (1.1%)	51 (1.3%)	120 (1.3%)
Anisometropia	129 (2.3%)	82 (2.1%)	211 (2.2%)
Anisocoria	18 (0.3%)	23 (0.6%)	41 (0.4%)
Total Referrals	**1384 (24.9%)**	**457 (11.4%)**	**19.25%**

Reason for referral

For the 2021–2023 school years, for both Title 1 and Non-Title 1 schools, the reason for referral was determined by evaluating screening data (Table 2). A large difference in referrals for astigmatism was noted between Title 1 (20.9%) and Non-Title 1 (7.5%) groups. Referrals for myopia were also twice as prevalent in the Title 1 (4.6%) vs Non-title 1 (2.3%) cohorts.

Eyewear and correction

For the 2021–2022 school year, Title 1 schools had 433 children who reported having an eyewear prescription and 278 (64.2%) of those children had eyewear on the screening day and wore eyewear during screening. Non-Title 1 schools had 223 children who reported having an eyewear prescription with 176 (78.9%) wearing correction on the screening day [Table 3]. For 2022–2023, Title 1 schools had 707 children reported to be wearing eye correction with 334 (47.2%) wearing correction on the screening day. Comparatively, Non-Title 1 schools had 342 children reported to be wearing eye correction with 210 (61.4%) wearing correction on the screening day. Out of all children screened, Title 1 schools had 16.2% of children reported to have eye correction in 2021–2022 and 24.4% in 2022–2023, with the percentage of children wearing correction on the screening day increasing from 10.4% to 11.5%. Non-Title 1 schools had 11.6% and 16.6% of children reported to have eye correction in 2021–2022 and 2022–2023, respectively, with children wearing correction on the screening day increasing from 9.1% to 10.2% over that time span.

Enrollment

Total enrollment at all schools where vision screenings were performed for the 2021–2023 school years (grades preschool through fifth grade) was 11,767, with 9,562 vision screenings occurring during this period for a screening rate of 81.3% of total enrollment. Of the overall total enrollment, Title 1 school enrollment for the 2021–2023 school years (grades preschool through fifth) was 7,044 with 5,568 vision screenings occurring during this period for

Table 3. Total numbers and percentages of children reported to require eye correction (by parent/guardian consent forms) and wearing correction at the time of screening for each group.

Year	% of Students:	Title 1	Non-Title 1	*p*-value
2021–2022	Have correction	433 (16.2%)	223 (11.6%)	$p < 0.001$
	Wore correction	278 (64.2%)	176 (78.9%)	$p < 0.001$
2022–2023	Have correction	707 (24.4%)	342 (16.6%)	$p < 0.001$
	Wore correction	334 (47.2%)	210 (61.4%)	$p < 0.001$

a screening rate of 79.1%. Non-Title 1 school enrollment for the 2021–2023 school years (grades preschool through fifth) was 4,723 with 3,994 children screened for a screening rate of 84.6%.

Discussion

Key findings

This study reports the results of childhood vision screenings performed by the KidsFIRST Free Vision Screening program at Rapid City Area elementary schools with comparisons of Title 1 and Non-Title 1 schools. Overall, referral rates have increased steadily from 11.4% in 2012 to 19.7% in 2023, with a disproportionate increase in Title 1 referral percentage (25.2% in 2023) compared to Non-Title 1 schools (11.9% in 2023) ($p < 0.0001$). Previous research by Terveen *et al.* utilizing the same study population identified a referral rate of 11.9% among all children with the SPOT photoscreener.[12] This increase is despite the photoscreener referral criteria remaining constant over this period.

Another finding from this data was related to the significant increase in referral rates, regardless of Title 1 status, following the change in vision screening registration format in 2021. The previous consent process for vision screening relied on paper forms sent home, in comparison to the new online consent process during online school registration. This is evidenced by the statistically significant increase in referral rates from 2012–2021 (12.2% 2021) to 2021–2023 (19.3%) ($p < 0.001$) and remained significant when just controlling for Title 1 status ($p < .001$). We hypothesize that this increase may result from the new consent method, which removed barriers for many children who stood to benefit most from vision screening. The mandatory online school registration for all students enrolling in Rapid City Area Schools offers a more efficient way for parents to provide consent during the registration process.

A large proportion of this study's vision screening referrals were for astigmatism, which was higher in the Title one group (2021–2023: Title 1 = 20.9%, Non-Title 1 = 7.5%). Of interest, increased risk for astigmatism has been associated with African American, Hispanic, and Asian children, while American Indians have a reportedly lower prevalence of astigmatism, according to some studies,[19,20] and a higher prevalence, according to other studies.[21] While race or ethnicity of the children referred was not analyzed in this study, further investigation as to whether significantly higher rates of astigmatism in Title 1 schools is related to racial differences in vision care is warranted. Higher rates of myopia are also associated with higher rates of astigmatism.[19] This may be reflected by the Title one group (4.6%) having twice as high of a referral for myopia than the Non-title one group (2.3%). Lack of access to health insurance is also associated with increased risk of astigmatism and vision loss in children, which could be a contributing factor in this study's population.[20]

We also considered the hypothesis that lifestyle changes during the COVID-19 pandemic may have led to an increase in myopia rates among children screened after the pandemic (2021–2023) compared to before (2012–2020). Increased screen time while learning at home is associated with a significant increase in myopic shift in six- to eight-year-olds.[22] Terveen et al. reported a myopia rate of 2.9% from the same study population from 2012 to 2014,[12] which is slightly lower than our reported total rate of referrals for myopia at 3.6%. While the pandemic may account for a slight increase in myopia in this population during this period, it does not explain the significant rise in astigmatism and other factors that contributed to the higher referral rate.

Comparison to prior research

Although our data show a significant difference in referral rates between Title 1 and non-Title 1 schools, our combined referral rates are still agreeable with previous research. A study conducted in Philadelphia schools utilizing the SPOT photoscreener demonstrated an overall referral rate of 17%.[15] However, our study's referral rate is lower than the 33% and 34% referral rate reported in two studies using the SPOT conducted primarily within Title 1 eligible schools in Baltimore, Maryland.[23,24] An additional study reported a 32% referral rate from SPOT photoscreening completed exclusively in Florida Title 1 schools.[24]

Further interventions

As research has demonstrated, taking the next steps toward treatment and management of vision concerns can have a positive impact on a student's academic performance,[6,7,25,26] as well as significantly increase the career earning potential of an individual.[12] While screening is a vital first step in identifying childhood vision problems, more intervention is needed. Research by Glewwe *et al.* demonstrated that providing screening along with free eye exams and eyeglasses to students with vision problems improved student achievement on standardized tests. Yet, no improvement in test scores were seen with the screening only (no glasses intervention) group.[25] In addition, if a majority of children in this study population referred for eye examination were seen by an eye care professional, prescribed glasses, and

wearing their glasses, an overall decreased referral rate on a yearly basis should be expected when screening a similar population over time. While this study demonstrates a 73% overall increase in referral rates since 2012, a slight increase in reported eye correction was noted (+8.2% for Title 1, +5.0% for Non-Title 1), indicating some children being referred for eye exams may be receiving appropriate correction.

Literature indicates children raised in families making two times the national poverty level are more likely to report adequate vision care than those from lower incomes,[13] indicating families from lower incomes may face more barriers to eye care utilization. It is likely that the socioeconomic factors that increase the likelihood of a child failing a vision screening are closely related to the barriers to attaining appropriate post-screening eye care evaluation and correction if needed. We believe interventions to address vision problems identified through vision screening in the form of a free, community-based eye care clinic will better allow direct coordination of screening efforts and follow-up care from eye care professionals, including dispensing of eye correction as necessary. A previous survey of the same population asking about perceived barriers to follow-up care indicated "affordability" as the biggest barrier to receiving eye care.[27] This aligns with past studies where "cost" was listed as the biggest hurdle in receiving eye care.[28]

Recommendations

Although a screening rate of over 81% was reported for all children receiving screenings since 2021 in this study, this leaves the remaining 19% of children in this community who would receive screening if childhood vision screening was mandatory. These figures do not reflect the many communities across the state that may lack access to free vision screening services. To address this gap, we recommend that South Dakota implement a statewide childhood vision screening policy. Although a comprehensive eye exam for every child would be ideal, photoscreening – such as the SPOT photoscreener used in this study – offers a practical solution. Its speed and ease of use make it an effective tool for screening large numbers of children, especially in resource-limited settings

Limitations

This study has many notable limitations. A lack of information regarding follow-up with eyecare providers following vision referrals, as well as results from any follow-up exams to determine the effectiveness of screening, is a limitation of this study.

Only 47% of Title 1 and 61% of Non-Title 1 students wore eye correction during the vision screening when they were listed as requiring correction, which likely played a role in the higher referral rates of the students during the 2022–2023 year. This may indicate that some students were identified as requiring correction when they in fact have an updated prescription at home, falsely elevating referral rates. Failure to wear correction could also be due to children choosing not to wear an outdated prescription, or a sign that further education of parents is needed regarding the importance of glasses for correction of significant refractive error and prevention of progression to amblyopia. Overall, the large number of students who reported owning correction but were not wearing correction on the day of screening adds complexity when recommending interventions.

A limitation of the SPOT photoscreener is the device's reportedly low sensitivity for detecting hyperopia and strabismus, two important causes of amblyopia during early childhood.[29,30] This is likely a large reason why our studies reported hyperopia referral rate (0.7–1.0%) is much less than the expected prevalence in the studied population.[31,32] This may indicate that some children screened are not being referred for eye examination, although they may benefit from it. In addition, though the AAPOS vision screening guidelines have been redefined in 2021 to better reflect age differences in reducing amblyopic risk factors, screening referral criteria were not updated on the SPOT photoscreeners utilized for this study to maintain consistency when comparing data across multiple years.[27] While photoscreening has its limitations, we believe it has significantly increased the number of children being referred for eye examinations who might otherwise have been missed. Additionally, we emphasize to parents that screening is not a substitute for a comprehensive eye examination by a licensed provider. We acknowledge that more resources are needed to address disparities in our communities beyond photoscreening.

Another perceived limitation of this study is that a proportion of children screened were past the critical stage of visual development, making it unlikely to fully mitigate the effects of amblyopia in those older than 8 years. However, there are still significant benefits to screening older children, such as enhancing school performance and offering myopia reduction therapies, which underscore the ongoing value of these screenings in older children.[6,7,25]

Suggestions for further research

Further research is needed to address the impact of this vision screening on amblyopia reduction and school

performance in the population screened in this study. Additionally, an improved system for follow-up of vision screening referrals to determine which students received eye exams following screening is necessary. Additional demographic data would also contribute to the discussion of amblyopia rates in the population screened.

Summary

This research highlights a significantly higher referral rate from vision screenings performed at Title-1 schools. We suggest that statewide legislation mandating vision screening for children would aid in addressing inequities in visual health. Overall, this research indicates that families with reduced resources may have higher rates of amblyopia risk factors and uncorrected significant refractive error, making it critical that healthcare policies and vision screening programs are mindful of these disparities so that they may begin reducing barriers for equitable eyecare.

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