Comparing the effectiveness of vision screenings as part of the school entrance physical examination to comprehensive vision examinations in children ages 3 to 6: An exploratory study

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Abstract

PURPOSE: The purpose of this exploratory study was to investigate the effectiveness of vision screenings performed during school entrance physical examinations compared with comprehensive vision examinations in the state of Kentucky, which mandates comprehensive eye examinations for children, ages 3 to 6, who are entering the public school system.

METHODS AND SUBJECTS: In this exploratory study, 1,386 children had forms submitted from 36 optometrists and 1 ophthalmologist reporting on their vision and eye problems. Vision and eye problems were defined as the presence of strabismus, amblyopia, or a refractive error requiring an optical correction, as determined by the optometrists or ophthalmologist using cycloplegic refraction. Among these 1,386 children, there were 300 diagnosed with vision problems.

RESULTS: Sixty-six children were diagnosed with a vision problem who had not previously been to an eye doctor and had received a vision screening at their school entrance physical examination. In 56 of these 66 children, the vision problem was not detected by the vision screening, according to the parents.

CONCLUSION: The exploratory study suggests that comprehensive vision examinations may identify some vision problems that were not found in children’s preschool physical examinations that included vision screenings. A larger randomized study is needed to determine the most appropriate method of timely diagnosis of vision problems in children that can be corrected with early intervention in order to ensure the vision health and well-being of children entering the public school system.

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KEYWORDS Vision screening; Comprehensive vision examination; School entrance physical examination; Vision problems

Comprehensive vision examinations and vision screenings are complementary tools that are used to address the vision care and vision health needs of children in the United States.1 In 2000, the Kentucky General Assembly passed the first law in the United States mandating that students 3 to 6 years of age have a vision examination by an optometrist or ophthalmologist and submit evidence of the examination before January 1 of each student’s first school year.2 Since then, several states have either passed or considered hybrid legislation that mandates a vision screening and...
requires a full vision examination for all children who fail the screening. Although these laws have intuitive appeal, it is important to evaluate them to understand the evolving model of vision care for children. The purpose of this exploratory study is to investigate the effectiveness of vision screenings as part of the school entrance physical examination versus comprehensive vision examinations in children ages 3 to 6.

One of the threshold questions in any discussion of new mandates for health services is cost effectiveness. The Kentucky law addresses the potential financial burden of the mandate by creating a funding mechanism for low-income families without third-party coverage. The statute was enacted as part of the 2000 Early Childhood Development Act (308 Ky. Acts Part 3 [11] [g]), which uses Master Settlement Agreement funds received from tobacco-related litigation to support a variety of interventions for small children. The legislation initially appropriated $150,000 per year to assist needy families with the cost of the examination. In reality, far less funding was necessary: annual expenditures ranged from a high of $3,600 in fiscal year (FY) 2002, to a low of $855 in FY 2004. Consequently, in 2004 the funding allocation was reduced to $5,000 per year and has remained there in FY 2005 and FY 2006.

Two important limitations of vision screening have been identified in the research literature. First, even with the most sophisticated vision screening techniques and trained vision screeners, approximately 1 of every 3 preschoolers with a vision problem is not identified. Included in the limitations of vision screenings is the lack of follow-up care by the parent or guardian after a failed vision screening. It has been estimated that 40% to 67% of children who fail a vision screening do not receive the recommended follow-up care.

In the United States, vision disorders are considered one of the most prevalent handicapping conditions in children. The importance of vision in a multidisciplinary approach to children’s educational environment and performance is supported in the literature. The prevalence of undetected vision problems is even higher for academically at-risk students, behaviorally at-risk students, and adjudicated delinquents.

Methods and subjects

The purpose of this study was exploratory. It was designed as a simple 1-stage cluster sampling with each cluster representing 1 eye care practitioner (ECP). For each doctor in the sample, reporting forms were completed for every child satisfying the inclusion criteria. The reporting form was designed and pilot tested by the principal investigator and authors in a sample of 52 patients. Initial findings prompted refinements of the reporting form, including the addition of fields for reporting insurance coverage. (Survey forms and procedures appear in the Appendix.) To identify
The criterion for amblyopia was the best-corrected visual acuity of 20/40 or worse. Classification of refractive errors and descriptions of prescribing patterns of the participating doctors were deemed beyond the scope of this study. Classification of amblyopia for children with bilateral reduced visual acuity was limited to those with other amblyogenic factors. All reported cases of amblyopia were reviewed by the investigators before they were classified as amblyopic. Strabismus was defined as the manifest deviation of the primary lines of sight of 1 prism diopter or more. Any tropia observable by cover test was considered to be strabismus. Refractive error was determined by cycloplegic examination utilizing 1 drop of 1% cyclopentolate in each eye followed in 5 minutes by a second drop of 1% cyclopentolate with a minimal time interval of 30 minutes before refraction.14

Payment types for the eye examinations were divided into public insurance, private insurance, and uninsured. Parental questioning and completion of the comprehensive examination were performed within the context of normal procedures in each practitioner’s office. To complete the reporting form for each subject, the case history must have included the reason for the visit, previous eye examinations, the results of a previous vision screening, information about who performed the vision screening, and whether the patient was referred for a comprehensive vision examination as a result. The patient’s history was obtained by the doctor, the doctor’s assistant, or by parents or guardians completing the information forms in the doctor’s office. It is assumed that if the parent or guardian was unable to provide this information, then the reporting form for that child was not completed. The performance and results of a vision screening by primary care providers during school entrance physicals were reported by parents or guardians. Although there are limitations when relying on parental or guardian reporting, medical record audits at the primary care provider level were beyond the scope of this investigation.

Of the 1,386 children included in the study, 682 were boys and 704 were girls. The proportion of African-American children in the study group was 5%, and the proportion with publicly funded health coverage through Medicaid or the State Children’s Health Insurance Program was 55.2%.

Twenty-five percent of the children were privately insured, and 18.4% were uninsured.

## Results

### Presence of vision problems

Of the 1,386 children whose examinations were included in this study, the largest group was the 5-year-olds, with 496 children examined (35.79%), followed by 4-year-olds, (426, 30.74%), 3-year-olds (239, 17.24%), and 6-year-olds (225, 16.23%).

Table 1 presents the total number of children with vision problems by age and the total number of children diagnosed with vision problems who had not received prior vision examinations according to the parent or guardian’s report at the time of the school entrance vision examination. Among the children with a vision problem, a majority had never been examined by an optometrist or ophthalmologist.

Table 2 is a follow-through summary of the 300 children who had reported vision screening problems before their full examinations came from a total of 20 ECPs, whereas the 56 children with previously undetected problems represented the reports of 18 ECPs.

Table 3 delineates the number of children whose vision problems would not have been diagnosed had they relied only on a screening and had not received a school entrance vision examination. The failure to identify vision problems was most noteworthy in younger children. If not for the comprehensive eye examination, 28 of the 3-year-olds and 50 of the 4-year-olds in this study would probably have

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Table 1  Algorithm of children with diagnosed vision problems (follow-through summary)

<table>
<thead>
<tr>
<th>All children with identified vision problems (subgroup)</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child has seen eye doctor</td>
<td>119</td>
</tr>
<tr>
<td>Child has not seen eye doctor</td>
<td>172</td>
</tr>
<tr>
<td>Child has not had school physical</td>
<td>37</td>
</tr>
<tr>
<td>Child has had school physical</td>
<td>133</td>
</tr>
<tr>
<td>Physical did not include vision screening</td>
<td>62</td>
</tr>
<tr>
<td>Physical included vision screening</td>
<td>66</td>
</tr>
<tr>
<td>Problem found on vision screening</td>
<td>7</td>
</tr>
<tr>
<td>Problem not found on vision screening</td>
<td>56</td>
</tr>
</tbody>
</table>

**Note:** These responses do not include those of parents who answered “don’t know.”

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### Table 1: Number of children with diagnosed vision problems

<table>
<thead>
<tr>
<th>Age</th>
<th>Total children in study sample</th>
<th>Total with vision problem</th>
<th>Number with diagnosed vision problem with no prior eye examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 y</td>
<td>239</td>
<td>36</td>
<td>30</td>
</tr>
<tr>
<td>4 y</td>
<td>426</td>
<td>77</td>
<td>52</td>
</tr>
<tr>
<td>5 y</td>
<td>496</td>
<td>100</td>
<td>61</td>
</tr>
<tr>
<td>6 y</td>
<td>225</td>
<td>87</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>1386</td>
<td>300</td>
<td>172</td>
</tr>
</tbody>
</table>

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## Table 1: Number of children with diagnosed vision problems

- **Table 1** presents the total number of children with vision problems by age and the total number of children diagnosed with vision problems who had not received prior vision examinations according to the parent or guardian’s report at the time of the school entrance vision examination. Among the children with a vision problem, a majority had never been examined by an optometrist or ophthalmologist.

- **Table 2** is a follow-through summary of the 300 children who had reported vision screening problems before their full examinations came from a total of 20 ECPs, whereas the 56 children with previously undetected problems represented the reports of 18 ECPs.

- **Table 3** delineates the number of children whose vision problems would not have been diagnosed had they relied only on a screening and had not received a school entrance vision examination. The failure to identify vision problems was most noteworthy in younger children. If not for the comprehensive eye examination, 28 of the 3-year-olds and 50 of the 4-year-olds in this study would probably have
entered school without having their vision problems diagnosed compared with 51 of the 5-year-olds and 26 of the 6-year-olds.

Of the 300 children who had vision problems diagnosed in this study, 63 had amblyopia. Of these 63 children who had amblyopia diagnosed, 18 had seen an eye specialist before their comprehensive vision examinations, and 45 had not seen an eye specialist before their comprehensive vision examinations. Of the 45 children with amblyopia who had not seen an eye specialist before their vision examinations, 40 had received a school entrance physical examination, and 5 did not have a school entrance physical examination. Of the 40 who had a school entrance physical examination, 25 had received vision screenings, 14 did not receive vision screenings, and 1 could not remember. Of the 25 children who had vision screenings, 2 vision problems were found in the screening, and 22 problems were not found in the vision screenings; 1 did not remember. Therefore, of the 63 children with amblyopia, 41 probably would not have been diagnosed without the mandated school entrance vision examination.

**Discussion**

**Presence of vision problems**

Of 1,386 children in this study, there were 300 children who were diagnosed with vision problems by their ECPs. Of these 300 children, there were 66 who reported having a vision screening during their school physical examination, and they had no previous visits to an eye care practitioner. In 56 of these 66 children, the vision or eye problem was not detected by the vision screening during the school entrance physical examination, according to the parents or guardians. The 56 children with missed vision problems included 22 with amblyopia and 13 with strabismus. A process dependent solely on vision screenings during preschool physical examinations has several points of vulnerability: the child may not receive a timely preschool physical, the primary care provider may not perform a vision screening during the preschool medical examination, the parent may not understand the primary care provider’s comments regarding findings from the vision screening, or the parent may not pursue additional testing despite the recommendation of the primary care provider. More than half of the children in this study would not have had their vision problem diagnosed if they had not received the mandated school entrance vision examination. This problem was even more acute for the younger children in this study. Even if these children eventually received a diagnosis and treatment was initiated, the late diagnosis may have prevented them from benefiting optimally from treatment. 15

**Limitations**

Parental self-report, although commonly used in research on children’s health services, may not be the most reliable indicator of some important variables, notably, the performance of vision screening by primary care providers during preschool physicals. However, it seems reasonable to assume that parents who were informed of vision problems by their children’s physicians would recall that information and relate it at a vision screening. Relying on questionnaires completed by parents or guardians raises questions regarding whether the parents or guardians understood the interpretation of the vision screening. However, this problem is inherent in the vision screening process and contributes to undiagnosed vision problems. Even if the parent is told of the existence of a vision problem by the physician during the physical, if there is no understanding or action on the part of the parent, then the result is the same as failure of the vision screening to disclose the problem. It is realistic to include dependence on parental recall as a factor in the assessment of the vision screening process.

Although a school entrance examination is mandated by law, there are no data available to verify that all parents are in compliance. Therefore, parents presenting for comprehensive examinations for their children may be doing so because they already suspect vision problems. Similarly, parents of children receiving a vision screening at the school physical may be less likely to comply with the mandate, especially if they do not understand the limitations of the vision screening process.

The goal of this exploratory study was not to determine estimates of the inclusion of vision screenings in school physical examinations but rather to do a preliminary assessment about the effectiveness of the vision screening process as part of the school entrance physical examination. There-

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Unidentified vision problems by age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-year-olds</td>
</tr>
<tr>
<td>Number of children with vision problem</td>
<td>36</td>
</tr>
<tr>
<td>Child has not had previous eye examination</td>
<td>30</td>
</tr>
<tr>
<td>Child has not had school physical</td>
<td>10</td>
</tr>
<tr>
<td>Physical did not include vision screening</td>
<td>8</td>
</tr>
<tr>
<td>Problem not found on vision screening</td>
<td>10</td>
</tr>
<tr>
<td>Failure to identify vision problem</td>
<td>28</td>
</tr>
</tbody>
</table>
fore, the finding that more than half of the children in this study would not have had their vision problem diagnosed if they had not received the mandated school entrance vision examination, although not generalizable, is, at the very least, alarming and suggests the need for further research.

Conclusions

The findings of this exploratory study suggest that comprehensive vision examinations may identify some vision problems that were missed in children’s preschool vision screenings. Of the initial 1,386 children, only 66 children met all the criteria of this study. The extent to which the sampling frame is representative of the population of children entering school cannot be determined, so these preliminary findings may not be generalizable. A much larger randomized study is indicated to determine the most appropriate method for timely diagnosis of vision problems in children that can be corrected with early intervention. The application of additional research will help to ensure the visual health and well-being of children entering the public school system.

Acknowledgments

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References

Appendix

Eye Exam Reporting Form

Please complete this form for every child age 3-6 that is seen for a comprehensive eye examination from 7/19/04-10/29/04.

Part 1

Demographic Data

Child’s birth date___________ Date of exam___________

Sex: ___ Male ___ Female Zip Code: _____________

Payment Type: _____ Self-pay _____ Private Insurance

_____ Public (Medicaid-KCHIP) _____ (KVP/S.F.S.) _____ Other

Questions to Caregiver

What group best represents [child’s first name]’s racial background?

___ White/Caucasian ___ Black/African-American ___ Asian/Pacific

___ Latino/Hispanic ___ Native American ___ Other

___ Refused
Are you aware of any problems with [child's first name]'s vision?

___ Yes  ___ No  ___ Not sure

Has [child’s first name] had their school entrance physical?

___ Yes  ___ No  ___ Not sure

(If yes) Was the physical performed by a _____ pediatrician _____ family doctor

_____ health clinic _____ other?

Were [child's first name] eyes screened as part of the physical?

___ Yes  ___ No  ___ Not sure

(If yes) Was a problem found with [child's first name]'s vision?

___ Yes  ___ No  ___ Not sure

Has [child’s first name] ever had an eye exam from an eye doctor?

___ Yes  ___ No  ___ Not sure

(If yes) Has [child’s first name] received any treatment to help with [his/her] vision?

___ Yes  ___ No  ___ Not sure

(If yes) What types of treatment has [child's first name] received?

Glasses: _____ yes  _____ no  _____ not sure

Patching: _____ yes  _____ no  _____ not sure

Eye Exercises: _____ yes  _____ no  _____ not sure

Surgery: _____ yes  _____ no  _____ not sure

Other therapy: _____ yes  _____ no  _____ not sure
### Part 2

#### Examination Data

Unaided Visual Acuity: OD 20/_____ OS 20/_____

Best Corrected Acuity: OD 20/_____ OS 20/_____

Amblyopia _____ neg _____ ref _____ strab _____ other

Strabismus _____ neg _____ ref _____ strab _____ other

Ocular Disease _____ pos _____ neg Type: ________________________________

**Refractive Error (Objective/minus cylinder):**

<table>
<thead>
<tr>
<th>(Type)_____</th>
<th>Retinoscopy</th>
<th>Auto Refractor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NON CYCLO</strong></td>
<td>Sph</td>
<td>Cyl</td>
</tr>
<tr>
<td>OD _____</td>
<td>_____</td>
<td>x</td>
</tr>
<tr>
<td>OS _____</td>
<td>_____</td>
<td>x</td>
</tr>
</tbody>
</table>

| **CYCLO** | Sph | Cyl | Axis | Sph | Cyl | Axis |
| OD _____ | _____ | x | _____ | _____ | _____ | x |
| OS _____ | _____ | x | _____ | _____ | _____ | x |

**Spectacle Rx (if prescribed)**

| OD _____ | _____ | x | _____ |
| OS _____ | _____ | x | _____ |
Survey Procedures
1. This form should be completed for all school entrance vision examinations on 3 to 6 year olds seen from 7/19/04 through 10/9/04. For ease of completion, the first part is designed to be completed by staff and the second part is to be completed by the examining doctor. All forms must be fully completed to be accepted.

2. All questions to caregiver must be worded verbatim per eye examination reporting form.

3. VISUAL ACUITY—for this study both unaided and best-corrected distance visual acuity must be performed using Snellen Acuity or equivalent.

4. AMBLYOPIA is defined as a unilateral or infrequently bilateral condition in which the best-corrected visual acuity is poorer than 20/20 in the absence of any obvious structural anomalies or ocular disease (AOA Clinical Practice Guidelines). For this study, we will use the criteria of best-corrected visual acuity of 20/40 or worse. Amblyopia is also to be classified as refractive amblyopia, strabismic Amblyopia, or other amblyopia.

5. STRABISMUS is defined as the manifest deviation of the primary lines of sight of 1 prism diopter or more (Anomalies of Binocular Vision: diagnosis and management). For this study, any tropia observable by cover test will be considered strabismus. It is also to be classified as esotropia, exotropia, or vertical.

6. OCULAR DISEASE for this study is the presence of a vision and/or eye abnormality that may cause the loss of ocular or lid function or be a sign of a systemic disease or disorder. It must also be recognized and have a defined CPT code. If an ocular disease is diagnosed, the diagnosis and CPT code must be stated.

7. RETRACTIVE ERROR for this study is the objective measurement of refractive power either by retinoscopy or auto-refractor. If done by auto-refractor, the type must be given. Refractive error must be measured both in a noncycloplegic and cycloplegic state. For cyclopegia, use 1 drop of 1% cyclopentolate in each eye followed in 5 minutes by a second drop of 1% cyclopentolate with a minimal time interval of 30 minutes before refraction (AAO Preferred Practice Patterns).

8. If a spectacle prescription is given, the power must be listed.

9. Payment types are divided into self-pay, private insurance, public insurance (M-caid, KCHIP), Kentucky Vision Project or Sight for Students, and other.

10. All reporting forms are to be mailed by 11/5/04 to:

11. U.K. College of Public Health
    121 Washington Ave.
    Lexington, KY 40536-0003