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Prevalence and Distribution of Corrective Lenses among School-Age Children

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Abstract

Background—No population-based data are available regarding the proportion of school-age children who have corrective lenses in the U.S. The objective of this study was to quantify the proportion of children who have corrective lenses (glasses or contact lenses) and to evaluate the association of corrective lenses with age, gender, race/ethnicity, health insurance status, and family income.

Methods—Children 6 to 18 years of age were identified in the 1998 Medical Expenditure Panel Survey. National estimates were made of the proportion with corrective lenses. Logistic regression modeling was used to assess factors that were associated with corrective lenses.

Results—Based on the 5,141 children in the 1988 Medical Expenditure Panel Survey, an estimated 25.4% of the 52.6 million children between 6 and 18 years had corrective lenses. Girls had greater odds than boys of having corrective lenses (odds ratio, 1.41; $p < 0.001$). Insured children, regardless of race/ethnicity, and uninsured nonblack/non-Hispanic children had similar odds of having corrective lenses. Compared with uninsured black or Hispanic children (odds ratio, 1), greater odds of corrective lens use was found among uninsured nonblack/non-Hispanic children (odds ratio, 2.29; $p = 0.002$) and black or Hispanic children with public (odds ratio, 1.67; $p = 0.005$) or private health insurance (odds ratio,1.77; $p = 0.004$). Among families with an income ≥200% of the federal poverty level, the odds of having corrective lenses increased with age ($p \leq 0.04$). In contrast, among those families <200% of the federal poverty level, the odds of having corrective lenses at 12 to 14 years was similar to 15- to 18-year olds ($p = 0.93$).

Conclusions—The use of corrective lenses suggests that correctable visual impairment is the most common treatable chronic condition of childhood. Income, gender, and race/ethnicity, depending on insurance status, are associated with having corrective lenses. The underlying causes and the impacts of these differences must be understood to ensure optimal delivery of eye care.

Keywords

eyeglasses; health services research; socioeconomic factors; child; adolescent

Correctable visual impairment, primarily due to refractive error, is common in childhood. Although vision screening for school-age children is widely recommended,[1-4] surprisingly little is known about the prevalence of visual impairment among these children or the proportion who receive treatment. The Orinda Longitudinal Study of Myopia, a population-based study in one school district in California, estimates that the prevalence of myopia (at

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least −0.50 D in both meridians) by 13 years of age is 20%.[5] We are unaware of any rigorous population-based study analyzing the rate of corrective lens use by school-age children in the U.S.

Utilization of vision care and subsequent receipt of corrective lenses results from the complex interplay between the prevalence of visual impairment, the effectiveness of detection, the ability to access treatment, and threshold for treatment. A survey from 1994 found that <2% of parents were unable to provide corrective lenses for their children who needed them.[6] This likely underestimates the true unmet need for corrective lenses because parents may be unaware that their children have a correctable visual impairment. Factors that could lead to unrecognized correctable visual impairment include lack of parent suspicion, missed or inaccurate vision screening, or inability to access vision care services.

Understanding the distribution of corrective lenses and the factors associated with the receipt of corrective lenses is critical to developing policies to ensure optimal eye care for children. There-fore, our goal was to develop a national estimate for the proportion of school-age children in the U.S. with corrective lenses and to analyze the association between having corrective lenses and factors typically associated with utilization of other preventive care services, including age, gender, race/ethnicity, family income, and health insurance status.[7-9]

METHODS

Data Source

Data were drawn from the household component of the 1998 Medical Expenditure Panel Survey (MEPS). The MEPS is a survey sponsored by the Agency for Healthcare Research and Quality to provide nationally representative estimates of healthcare use, expenditures, sources of payment, and insurance coverage.[10] The 1998 MEPS is based on a national probability sample of the U.S. civilian, noninstitutionalized population drawn from the 1996 and 1997 National Health Interview Survey. Minorities were over-sampled to add power for statistical inference. Poststratification sampling weights are provided to adjust the data to Census data and to correct for nonresponse. The 1998 MEPS had an overall response rate of 67.9% and includes data on 9,023 families representing 22,953 individuals.[10]

Subjects

Children 6 to 18 years are included in this analysis. This research involved anonymous and publicly available data. No institutional review board approval or informed consent was necessary.

Main Outcome Measure and Independent Variables

The main outcome measure for this analysis was whether the child had corrective lenses (glasses or contact lenses) based on family member report (usually parent or legal guardian). We evaluated the association between this outcome measure and the following independent variables: age, gender, race/ethnicity, family income, and health insurance status. Race and ethnicity were categorized as Hispanic, non-Hispanic black, and nonblack/non-Hispanic. Family income was adjusted for household size and categorized into <200% or ≥200% of the federal poverty level. We categorized health insurance status to summarize each child's health insurance experience during all of 1998. These categories were none, any period of public but no private insurance, and any period of private insurance.

Statistical Analysis

We first evaluated the relationship between each individual independent variable and the main outcome measure of having corrective lenses. To test for independence in these bivariate analyses, we calculated a modified Pearson χ^2 statistic corrected for the survey design. When bivariate analyses involved 2 × 3 cross-tabulations and the overall Pearson χ^2 was significant, pairwise comparisons were performed. The significance level was lowered appropriately (Bonferroni method) to reduce the probability of a type I error (i.e., considering an association as significant when, in fact, it was not).

Logistic regression modeling was used to determine the relative association between each significant independent variable and the main outcome measure. To ensure adequate statistical power, we collapsed race and ethnicity into a dichotomous variable: Hispanic or black and nonblack/non-Hispanic. We assessed for second-order interactions between all independent variables.

To account for the MEPS complex sampling strategy, coefficients and their variances were determined by appropriately weighted generalized linear models with pseudo-maximum likelihood estimators. All findings from the regression modeling are reported as odds ratios and their 95% confidence intervals. The adjusted Wald test with the covariance matrix for each variable from the logistic regression model was used to test for statistically significant differences among the model coefficients. For any model that included interaction terms, we calculated odds ratios for the combination of the main effect and the interaction term.

The bivariate analyses were performed using SAS (SAS Release 8.2; SAS Institute, Cary, NC) and SUDAAN (SUDAAN Release 8.0; Research Triangle Institute, Research Triangle Park, NC). For the logistic regression modeling, we used Stata (Stata 7; Stata, College Station, TX). Unless mentioned, all results are adjusted by the poststratification weights, and all percentages are weighted to reflect population-level proportions.

RESULTS

In the 1998 MEPS, 23.9% of the 5,141 children aged 6 to 18 years had corrective lenses. When weighted to the U.S. population, an estimated 25.4% (95% confidence interval, 23.8 to 27.0%) of the 52.6 million children aged 6 to 18 years had corrective lenses. Table 1 describes the distribution of population characteristics and the proportion with corrective lenses in the weighted MEPS sample for each characteristic.

Bivariate Analysis

We found significant differences in the distribution of corrective lenses across all of the variables of interest. The proportion of elementary school-age children who had corrective lenses (15.8%) was less than that of middle school-age children (30.8%; $p < 0.0001$) and of high school-age children (36.0%; $p < 0.0001$). No statistically significant difference was found between middle school-age children and high school-age children ($p = 0.018$; due to the Bonferroni adjustment, the threshold for significance was 0.017). Boys were less likely to have corrective lenses than girls (22.4% vs. 28.5%; $p = 0.0001$). Compared with nonblack/non-Hispanic children (27.5%), Hispanic children (20.9%; $p = 0.002$) and non-Hispanic black children (20.5%; $p = 0.004$) were less likely to have corrective lenses. There was no statistically significant difference between the proportion of Hispanic children or non-Hispanic black children who had corrective lenses ($p = 0.88$). Those with family income <200% of the federal poverty level were less likely to have corrective lenses than those ≥200% of the federal poverty level (19.3% vs. 29.0%; $p < 0.0001$). Children with public health insurance only during 1998 were less likely than those with any private health insurance to have corrective lenses (19.7% vs. 27.2%; $p = 0.0002$). There was no difference in the use of corrective lenses between those with public insurance and those who were uninsured (19.7% vs. 22.6%; $p = 0.35$).

Logistic Regression Analysis

Two of the interaction terms we tested, age and family income, and race/ethnicity and insurance, were significant ($p < 0.05$). The adjusted odds ratios and 95% confidence intervals from the resulting model are listed in Table 2.

Regardless of family income, children 12 to 18 years old had greater odds of having corrective lenses than children 6 to 11 years. Higher family income was associated with greater odds of having corrective lenses for both 12- to 14-year-old ($p = 0.04$) and 15- to 18-year-old ($p < 0.001$) children. Among those <200% of the federal poverty level, there was no increase in the odds of having corrective lenses by 15- to 18-year olds compared with 12- to 14-year olds ($p = 0.93$). In contrast, among those >200% of the federal poverty level, 15- to 18-year olds had greater odds than 12-to 14-year olds to have corrective lenses ($p = 0.004$).

After adjusting for all variables in the model, girls had 41% greater odds than boys of having corrective lenses ($p < 0.001$).

Children with either private or public insurance, regardless of race/ethnicity, had similar odds of having corrective lenses ($p > 0.32$ for all comparisons). Uninsured nonblack/non-Hispanic children had similar odds of having corrective lenses as children with insurance, regardless of their race/ethnicity ($p > 0.25$ for all comparisons). In contrast, uninsured black or Hispanic children had lesser odds of having corrective lenses than black or Hispanic children with either public ($p = 0.005$) or private health insurance ($p = 0.004$). Furthermore, the odds of uninsured black or Hispanic children having corrective lenses was 129% less than uninsured nonblack/non-Hispanic children ($p = 0.002$).

DISCUSSION

We found that in 1998, one in four noninstitutionalized children in the U.S. between 6 and 18 years of age had corrective lenses. Although this suggests that visual impairment is the most common treatable chronic condition of childhood, the rate of corrective lens use cannot be used to directly determine the prevalence of correctable visual impairment because of variations in access and utilization of eye care services. We found differences in the use of corrective lenses by gender, race/ethnicity, family income, and health insurance status. The observed disparities could arise from three factors: differences in prevalence within subpopulations of children, undertreatment in children with poor access or utilization of eye care services, or overtreatment in other children.

For at least 30 years, it has been recognized that black children are less likely than nonblack children to have corrective lenses.[11] The causes of this disparity have been unclear. In the past, the racial difference has been ascribed to differences in the prevalence of visual impairment.[12] Insufficient data are available to accurately determine the population-specific prevalence of visual impairment among black, Hispanic, or nonblack/non-Hispanic school-age children.

We found that uninsured black or Hispanic children had lower odds of having corrective lenses than other children, regardless of health insurance status (none, public, or private). However, black or Hispanic children with health insurance had similar odds of having corrective lenses as nonblack/non-Hispanic children. This suggests that differences in corrective lens use by race/ethnicity are based on utilization of eye care services, not underlying differences in prevalence.

No study has systematically evaluated insurance coverage for children's eye care services. Our ongoing research has found that, in general, public insurance will cover diagnostic eye examinations and corrective lenses. In contrast, coverage by private insurance varies greatly.

Many families, regardless of insurance status, pay out-of-pocket for glasses, either because insurance will not cover glasses or the frames that are covered are unappealing to the child. Furthermore, families often have to pay for replacement corrective lenses due to the child either losing or breaking the glasses. Outof-pocket expenses for diagnostic eye examination or corrective lenses may account for the large disparity we observed by family income.

As with racial differences in the use of corrective lenses, gender differences have long been recognized.[11, 12] The gender disparity persisted after controlling for health insurance status and family income. It is unclear whether the gender disparity is due solely to differences in the prevalence of visual impairment or whether there was a gender bias in the detection or treatment of visual impairment.

This analysis has three important limitations. First, cross-sectional analysis cannot demonstrate causation, only association. Second, we have no information on the corrective lenses, including reasons for the correction, lens strength, and frequency of use. These data would be helpful for determining whether the observed disparities are related to under- or overtreatment. Finally, there may be other factors not included in our analysis (e.g., rural/urban differences or eye care provider characteristics) that are important in the receipt of corrective lenses. A large population-based cohort study will be necessary to address these limitations and to fully understand the factors that gave rise to the observed disparities.

The impact of uncorrected visual impairment on education is controversial and difficult to evaluate.[13, 14] It is possible that the observed disparities in the distribution of corrective lenses may lead to an “education gap” due to undertreatment. In contrast, over-treatment may waste limited healthcare resources. Developing strategies to ensure the optimal and equitable delivery of eye care service would help to ensure that children maximize their developmental potential while minimizing excess expenditures. Future research should focus on the prevalence of correctable visual impairment and the costs and benefits of providing vision care services for school-age children.

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TABLE 1

Distribution of population characteristics and corrective lens use in the weighted 1 998 Medical Panel Expenditure sample

	Population Characteristic		Corrective Lens Use	
	Percentage	**95% Confidence Interval**	**Percentage**	**95% Confidence Interval**
Age				
6-11 yr	46.7	45.0-48.4	15.8	13.7-17.8
12-14 yr	21.8	20.6-23.1	30.8	27.5-34.0
15-18 yr	31.5	29.8-33.2	36.0	32.8-39.1
Gender				
Male	50.6	49.0-52.2	22.4	20.4-24.5
Female	49.4	47.8-51.0	28.5	26.1-30.8
Race/ethnicity				
Hispanic	14.6	13.0-16.5	20.9	18.0-23.8
Non-Hispanic black	16.0	13.7-18.5	20.5	17.0-24.0
Nonblack/non-Hispanic	69.4	66.7-72.0	27.5	25.2-29.7
Health insurance				
Uninsured	10.7	9.4-12.2	22.6	17.3-27.8
Public only	17.7	15.6-19.9	19.7	16.4-23.0
Any private	71.6	69.1-74.0	27.2	25.4-29.1
Family income				
<200% of the federal poverty level	37.0	34.5-39.6	19.3	16.9-21.7
≥200% of the federal poverty level	63.0	60.4-65.5	29.0	26.8-31.2

TABLE 2

Logistic regression analysis of the factors associated with the use of corrective lenses[a]

	Odds Ratio	95% Confidence Interval
Age and family income		
<200% of the federal poverty level		
6-11 yr	1.0	
12-14 yr	1.90[b]	1.38-2.61
15-18 yr	1.93[b]	1.38-2.69
≥200% of the federal poverty level		
6-11 yr	1.09	0.81-1.46
12-14 yr	2.80[b]	1.99-3.96
15-18 yr	3.98[b]	2.82-5.63
Gender		
Male	1.0	
Female	1.41[b]	1.21-1.65
Race/ethnicity and health insurance		
Black or Hispanic		
Uninsured	1.0	
Public insurance only	1.67[b]	1.17-2.39
Any private insurance	1.77[b]	1.20-2.63
Nonblack/non-Hispanic		
Uninsured	2.29[b]	1.35-3.89
Public insurance only	2.08[b]	1.33-3.27
Any private insurance	1.98[b]	1.42-2.78

[a]Odds ratios are adjusted for all factors presented.

[b]Odds ratio is statistically different ($p < 0.05$) from the reference.