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Original

Pediatric patients at a high risk of headache of ocular origin: the HAMS Score (Hyperopia, Astigmatism, Myopia, and Strabismus)

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Abstract

Background
Pediatric patients identified at increased risk for headache due to ocular refractive errors were evaluated to produce a diagnostic tool called the HAMS score that will help establish the likelihood of headache due to refractive errors.

Methods
Data on the ocular diagnosis and headache complaints of 726 pediatric patients of both sexes were obtained from the medical records of an ophthalmological service in Brazil (Hospital de Olhos Santa Luzia). Age, use of glasses, and ocular diagnosis were also considered to create an index based on the number of ocular diagnoses in a given individual (HAMS score) to verify their association with the incidence of headache. Once the database was finalized, it was then analyzed to identify the variables capable of predicting the occurrence of headaches, following which a profile of those at the highest risk was produced by comparison.

Results
Only the ocular diagnosis was significantly associated with headache as a function of sex, age, use of glasses, farsightedness, astigmatism, myopia, and strabismus, indicating the relative impact of each ocular diagnosis on the probability of headache. According to the HAMS score, strabismus is more likely to have headache (5.21), followed by hyperopia (3.10), myopia (2.67), and, finally, astigmatism (1.86). The findings showed that the presence or absence of refraction errors and strabismus is predictive of the occurrence of headache, particularly in a small group of patients (6.2%) where the probability of headache was 57.8%. Such patients were characterized by being younger, having a combination of strabismus, hyperopia, and astigmatism, and already be using corrective lenses.

Conclusion
The index based on the most common ocular diagnoses (HAMS score) is effective, and it has practical application in identifying children and adolescent patients with a greater or lesser propensity for headaches of ophthalmic origin.

Keywords:
Headache
Ocular diagnosis
Pediatric patients
Refractive Errors
Strabismus
Myopia

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Introduction

For more than one century, the relationship between eye and headache attacks has been studied.[1-19] Headache episodes of ocular origin can occur as a local event triggering a primary headache attack such as migraine.[20] The mechanisms involved in such cases are any affections that interfere with the correct functioning of the optical system, which might lead to a headache. This includes refraction errors (myopia, astigmatism, hyperopia), heterotropia (strabismus), inflammatory disease (keratitis, uveitis, scleritis), infections (corneal ulcers, conjunctivitis, endophthalmitis), and glaucoma (closed-angle, neovascular), as well as orbital pathologies (cellulitis, orbital pseudotumors, tendinitis), and any affection of the fifth cranial pair.[21-26]

Among children, the leading cause of headaches are migraine and tension-type headache,[27-29] though they are considered to be fairly rare, occurring in 2-5% of those below the age of 15 years, with the peak incidence occurring between the ages of 10 and 15.[30] Approximately 4.3% of the children and adolescents experience headaches by the age of two or three, with a gradual increase until they reach school age.[31] In adolescents, the figures tend to surpass 50%.[32]

Below the age of 10, primary headaches are generally more prevalent in males than in females,[33] but the female sex usually predominates during adolescence.[34] There is also an association with age itself, for complaints of headaches tend to increase as the children get older.[32,35,36] However, the role of ocular causes in headache medicine, particularly in children and adolescents, is still controversial.

Parents and caretakers of children with headaches frequently suspect the origin to be refraction errors.[37,38]However, corrective lenses usually do not change the characteristics or course of the headaches even when a refraction error is effectively diagnosed.[39] For this reason, when a child experiences headaches, one of the most commonly consulted specialists is the ophthalmologist.[38,40-44] The official word of the International Headache Society is that uncorrected refraction errors and heterotropia may cause headaches,[42] but their importance is enormously overestimated. Regarding heterotropia, it is read in the ICHD-3 that "there are a number of supportive cases for A11.3.5 Headache attributed to heterophoria or heterotropia but otherwise little evidence for this cause of headache. It has therefore been moved to the Appendix pending more formal study."[42]

A case series of pediatric patients seen at an ophthalmology service with complaints of headache were analyzed with the aim of producing a useful diagnostic tool called the HAMS Heavy Score. This tool will help establish the likelihood of headache due to refractive errors and heterotropy and provides a checklist of attributes that may help identify pediatric patients at increased risk for ocular headache.

Methods

Sample

The present study included data from 726 patients, between 3 months and 19 years, brought to an ophthalmological service (Hospital de Olhos Santa Luzia) in Recife, Pernambuco, Brazil, between January and October of 2011. The independent variables age, sex, use of glasses, headache complaint and ocular diagnosis, to create an index based on the number of diagnoses of hyperopia, astigmatism, myopia and strabismus on a given individual (HAMS Score) were considered to verify their association with the incidence of headaches. Table 1 shows the distribution of age and sex for the series obtained.

Table 1. Sex and age of the patients

Age (years)	Sex				Total	
	Male		Female			
	n	%	n	%	n	%
0 to 4	105	31.0	122	31.5	227	31.3
5 to 8	106	31.3	120	31.0	226	31.1
9 to 12	114	33.6	121	31.3	235	32.4
13 to 19	14	4.1	24	6.2	38	5.2
Total	339	100	387	100	726	100

There were no differences between the two sexes regarding age (z=0.061 and p=.95 in the Mann-Whitney U test).

Of the total patients, 46.4% had hyperopia, 34.6% astigmatism, 13.2% strabismus, and 5.8% myopia, with 39.0% presenting other diagnoses. There was a significant variety; however, none surpassed 2.8% of the sample (i.e., all had only 20 cases or fewer). Only the diagnoses of refraction errors or heterotropia were considered frequent enough for statistical evaluations. 25.2% of the patients wore glasses, and 18.1% complained of headaches.

Analysis

Logistic regressions were used to measure the explanatory

power of the independent variables in estimating the probability of headache while controlling for covariance effects. The first group of independent variables considered was: age, sex, use of glasses, headache complaint, and ocular diagnosis; the other group considering the variables: hyperopia, astigmatism, myopia, and strabismus. An index was created based on the regression results that differentiates those with a greater or lesser chance of headache based on the ocular diagnosis.

Results

Only the ocular diagnosis gave a significant association with headache as a function of sex, age, use of glasses, hyperopia, astigmatism, myopia, and strabismus (Table 2). Sex, age, and the use of glasses, on the other hand, did not emerge as having such an association when one controlled for the existence of refraction errors and strabismus.

Table 2. Logistic regression of headache complain as a function of sex, age, use of glasses, hyperopia, astigmatism, myopia, and strabismus

Method: Quasi-Newton			
Chi^2=93.442 p<.01			
Sensitivity = 15.3%; Specificity = 97.3%			
Positive Predictive Value = 55.6%; Negative Predictive Value = 83.9%			
Variable	Beta	*Odds-Ratio*	Wald chi-square (p)
Female sex	0.35	1.42	0.10
Age	0.02	1.07	0.87
Use of glasses	-0.45	0.64	0.11
Myopia	1.25	3.50	0.01
Hyperopia	1.18	3.26	<0.01
Astigmatism	0.79	2.20	<0.01
Strabismus	1.78	5.93	<0.01
Constant	2.70		<.01

The low sensitivity observed considering only hyperopia, astigmatism, myopia, and strabismus as independent variables can be explained by: (a) the relatively low incidence of headache (18.0%) in the sample, and (b) the generic and unspecific nature of headaches as a symptom. Regardless of this, these findings demonstrate the existence of explanatory power of the ocular diagnosis when it comes to headaches (Table 3).

The odds ratios found for each of the diagnoses indicate the relative impact of each ocular diagnosis upon the probability of headache. Therefore, it may be said that strabismus has the most significant effect (5.21), followed by hyperopia (3.10), myopia (2.67), and, lastly, astigmatism (1.86).

Table 3. Logistic regression of headache complain as a function of hyperopia, astigmatism, myopia, and strabismus

Method: Quasi-Newton			
Chi^2= 88.232 p<.01			
Sensitivity = 12.2%; Specificity = 97.5%			
Positive Predictive Value = 51.6%; Negative Predictive Value = 83.5%			
Variable	Beta	*Odds-Ratio*	Wald chi-square (p)
Myopia	0.98	2.67	0.03
Hyperopia	1.13	3.10	<0.01
Astigmatism	0.62	1.86	0.01
Strabismus	1.65	5.21	<0.01
Constant	2.79		<0.01

Cumulative Impact of Refraction Errors and Strabismus

The number of diagnoses of hyperopia, astigmatism, myopia, or strabismus on a given individual (HAMS Score) is a measure of the number of combined ocular disorders one may have. Roughly, 39.0% have a score of zero, 26.4% a score of one, 30.2% a score of two, and only 4.4% a score of three.

The HAMS Score can be used to determine the cumulative effect of refraction errors and heterotropia on the probability of headache, as shown in Figure 1.

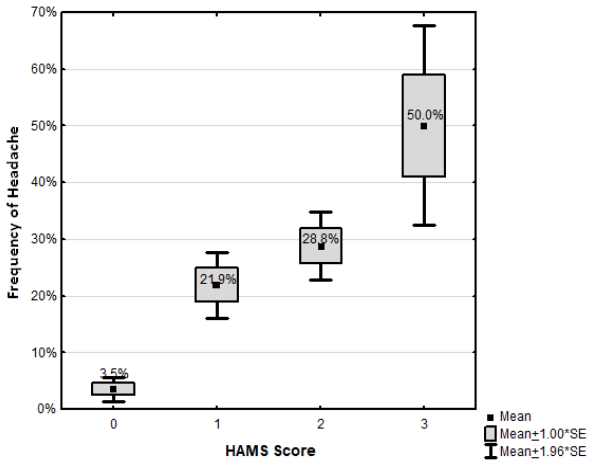

Figure 1. The frequency of children with headache in relation to the HAMS (Hyperopia, Astigmatism, Myopia, and Strabismus) Score.

One can see that there is a clear trend towards an increase in the incidence of headache as the HAMS Score gets higher, with the probability of headache being only 3.5% when the score is zero but climbing as high as 50.0% when the score is three. This makes such a score a somewhat valuable tool.

However, despite its usefulness and simplicity, the HAMS Score has the fundamental flaw of considering all four ocular diagnoses (i.e., hyperopia, astigmatism, myopia, and strabismus) as having equal weight. At the same time, the analysis in Table 4 clearly shows that this is not the case. One way to correct this is to create a version of the score where the weight of each component is given by the odds-ratio obtained in the logit regression so that a Weighed HAMS Score can be produced according to the following formula:

*Weighed HAMS Score=5.21 *Strabism.+3.10+Hyperop. +2.67*Myop.+1.86*Astigm*

For the sample studied, the distribution of the Weighed HAMS Score was such that 39.0% had a value of zero, 20.0% a value between 0.1 and 4.1, 34.9% a value between 4.1 and 8.0, and 6.2% a value of 8.1 or higher. Figure 2 shows the relationship between the Weighed HAMS Score and the incidence of headache in the present study.

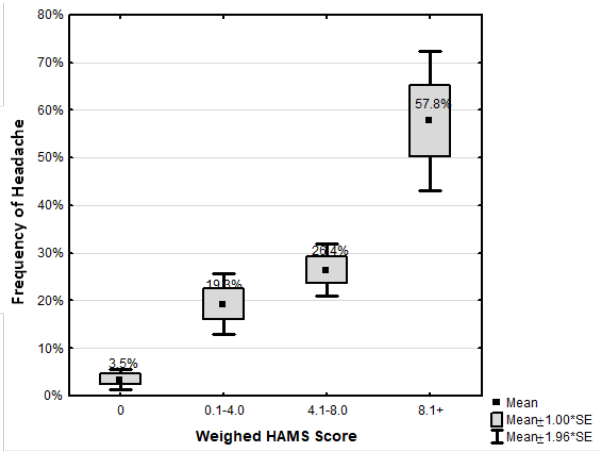

Figure 2. The frequency of children with headache in relation to the HAMS (Hyperopia, Astigmatism, Myopia, and Strabismus) Score.

In Figure 2, there is a clear trend towards an increase in the frequency of headache as the Weighed HAMS Score gets higher. The probability of headache was only 3.5% when the score was zero, but it became as high as 57.8% when the score was 8.1 or more. The Weighed HAMS Score has the advantage of producing a more significant differentiation between the probabilities of highest and lowest levels (57.8% versus 3.5%, a ratio of 16.51) than the one obtained by the simple HAMS Score (50.0% versus 3.5%, a ratio of 9.43). Furthermore, the margin of error in the estimation of the probability of the highest level of the score was smaller in the case of the Weighed HAMS Score (25.3%) than in the simple HAMS Score (35.2%).

Profile of pediatric patients with a high risk for headache of ocular origins

Table 4 compares the patients with a score on the Weighed HAMS Scale that is equal to or greater than 8.1 with those with a score below 8.1, with regards to sex, age range, use of glasses, refractory errors, and strabismus. The patients with a higher Weighed HAMS Score were much more prone to experiencing headaches (57.8% versus 15.4%). As to their other traits, statistical differences were found regarding:

Table 4. Comparison between patients with a higher (>8.1) and lower (<8.1) Weighed HAMS (Hyperopia, Astigmatism, Myopia, and Strabismus) Score

Variables		Weighed HAMS Score		Canonical test (p)
		≥ 8.1 (n=45)	<8.1 (n=681)	
Sex	Male	44.4%	46.8%	0.76
	Female	55.6%	53.2%	
Age (years)	0-4	42.2%	30.5%	0.10
	4-8	35.6%	30.8%	0.51
	8-12	15.6%	33.5%	0.01
	>12	6.7%	5.1%	0.66
Refraction Errors	Hyperopia	93.3%	43.3%	<0.01
	Astigmatism	68.9%	32.3%	<0.01
	Myopia	6.7%	5.7%	0.79
Strabismus		100%	7.5%	<0.01
Use Glasses		80.0%	21.6%	<0.01
Headache		57.8%	15.4%	<0.01

. Age: Among those with higher Weighed HAMS Score, there were fewer patients in the 8 to 12-year-old bracket and, marginally, more patients in the 0 to 4-year-old range (adjusted Z=-2.024 and p=.04 on the Mann-Whitney U test for the difference in age as a whole, with the higher Weighed HAMS Score group being younger);

. Refraction Errors: The group with higher Weighed HAMS Score had a much greater proportion of patients with hyperopia (93.3% versus 43.3%) and astigmatism (68.9% versus 32.3%);

. Strabismus: All patients in the higher Weighed HAMS Score group (100%) had strabismus, whereas there were only 7.5% of the lower Weighed HAMS Score group with this condition;

. Use of Glasses: About 80.0% of the high Weighed HAMS Score group wore glasses, while only 21.6% of the others did the same.

Interestingly, though 100% of the high WBS group had strabismus, such group represents only 46.9% (45 out of 96) of all the patients with that condition.

Discussion

Age, Sex, Glasses, and Headache

Once one controlled covariance with other variables, particularly refraction errors and strabismus, there was no association between sex, age, glasses, and headache. This suggests that an increase in the prevalence of headaches in the female sex and older children might not be a consequence of sex and age per se, but rather the association between such things and other factors (covariance), particularly with ocular diagnoses.[44-46]

Ocular Diagnoses and Headache

Logistic regression of the incidence of headache as a function of the ocular diagnosis showed that strabismus was the strongest predictor of headaches (odds-ratio of 5.21), followed by hyperopia (odds-ratio of 3.10) and myopia (odds-ratio of 2.67), with astigmatism having the smallest impact (odds-ratio 1.86). This may be due to the specific mechanisms involved in such affections, such as the practical impact on vision and eyestrain.

It is important to note that only one-tenth of all the patients with headache at the ophthalmological service can be explained by ocular diagnoses, which is consistent with the existence of a myriad of causes of headache, and also with the fact that headaches in children and adolescents have a relatively low.[39,44] However, such a percentage of patients with headache that can be predicted by ocular diagnoses is large enough to be relevant in clinical practice, and, as it will be discussed in the following subsection, there is a cumulative effect that, under certain conditions, are associated to a probability of more than 50% of a headache occurs.

HAMS and the Cumulative Impact of Ocular Diagnoses

The accumulation of HAMS diagnoses was shown to be associated with a fairly dramatic increase in the incidence of headache in this series (from 3.5% to 50.0%, a relative risk of 9.43), especially when one ponders the individual impact of each specific diagnosis (from 3.5% to 57.8%, a relative risk of 16.51).[39,46] Such a finding suggests that ocular problems, particularly refraction errors and strabismus, have a relevant impact on the occurrence of headache among children and adolescents, especially when such issues accumulate in the same patient. In the most extreme cases (Weighed HAMS Score >8.1), which encompass 6.2% of the patients studied, the probability of headache can be as high as 57.8%, meaning that, for them, it is more likely that a headache will occur than that it will not.

Profile of High-Risk Pediatric Patients

Based on the Weighed HAMS Score, the present study results showed that pediatric patients at high risk for headaches of ocular origins tend to be younger, with a greater prevalence of those in early childhood than those above four. In terms of ocular health, all of them had strabismus (100%), almost all had hyperopia (93.3%), and more than two-thirds of them had astigmatism (68.9%), which is why the vast majority wore glasses (80.0%). Considering these findings, it would appear that younger patients with strabismus plus hyperopia and astigmatism, even though most of them already use corrective lenses, should be considered at high risk for suffering from headaches of ocular causes; thus requiring special attention on behalf of the ophthalmologist regarding the investigation of causes and planning of treatment, including the possibility of a consultation with a neurologist.

Conclusion

Is possible and relatively easy to construct an index based on the most common ocular diagnoses (Weighed HAMS Score), which is of practical application in identifying patients with a greater or lower propensity towards headaches of an ophthalmological origin. Ocular diagnoses, particularly hyperopia, astigmatism, myopia, and strabismus, seem to play a relevant cumulative role in the occurrence of headaches in children and adolescents, especially in the small number of patients where such ocular affections are combined to a significant degree. In this particular subgroup, it is more likely that headache episodes will occur.

The group of patients with a very high propensity for headache episodes is characterized by being younger, having a combination of strabismus, hyperopia, astigmatism, and already using corrective lenses. The risk is so significant that it should be presumed that these patients will have headaches. The accompanying measures of such an assumption (further investigation, treatment planning, consulting with other experts) appear to be taken by negligence.

Future studies on the subject of the relationship between ocular diagnoses and headache should include a substantially larger series of patients than the present to allow for the evaluation of the impacts of ophthalmological diseases other than HAMS, as well as a more detailed description of the headache characteristics (intensity, location, duration) and the ocular health, along with data on treatments and outcomes, to provide a complete view of the phenomena observed, thereby allowing one to obtain findings capable of shedding light upon the possible mechanisms involved, as well as producing more accurate diagnostic and prognostic models, as well as profiles.

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