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Biosocial Determinants of Concomitant Strabismus in Children and Adolescents: A Hospital-Based Observational Study

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Abstract

Background: To study biosocial factors associated with concomitant strabismus in children and adolescents attending the ophthalmic outpatient department of a tertiary health care Institute in north India. **Methods:** A total of 235 patients of strabismus, aged between 4-19 years and with deviation ≥ 15 prism dioptres were included in this study over three years from July 2017 to June 2020. Data were collected by a predesigned, pretested questionnaire which included various biosocial factors and obstetric history of the patient. **Results:** The mean age of the study population was 13.01± 5.71years (Range = 4 - 19 years). Out of 235 patients, 126 (53.6 %) were male and 109 (46.4%) were female. 86 (36.6%) patients had esotropia, 124 (52.85%) had exotropia and 25 (10.6%) were in a miscellaneous group.Only 18 (7.66%) patients had a family history of strabismus and all of them had exotropia. Amongst the obstetric history, there was a statistically significant association between type of strabismus and birth weight, wherein 3(3.5%) of the esotropes, 2(1.6%) of the exotropes, and 3(12.0 %) of the miscellaneous group had a birth weight of <1500grams (p =0.046). Fourteen (16.3%) of the esotropes, 6(4.8%) of exotropes and 1(4.0%) of the miscellaneous group had an illness within 6 months of birth that required hospitalization and medical intervention (p =0.015). **Conclusion:** There was a statistically significant association between esotropia, miscellaneous type of deviations and birth weight <1500 grams; and also between esotropia and illness requiring hospitalization within 6 months of birth.

Keywords: Concomitant Strabismus, Biosocial Determinants, Risk Factors of Strabismus, Children, Adolescents.

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Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

INTRODUCTION

Strabismus is a common ocular disorder of childhood with prevalence ranging from 0.8% to 5.65%.[1-9] It is a misalignment between visual axes of the two eyes leading to poor binocular interaction. It is one of the most common causes of amblyopia. It has a multidimensional impact on a person's life including low self-esteem, low confidence, depressive mood disorder, feeling of loneliness, reduced interpersonal relationship, reduced employment, and social prejudice. Thus, it affects the quality of life of the affected person.[10-14]

It has been postulated to be associated with various biosocial risk factors including a family history of strabismus, maternal factors such as smoking or alcohol use during pregnancy, perinatal factors such as intrauterine growth retardation, prematurity, low birth weight, birth asphyxia, obstructed labour, and birth trauma, postnatal factors like history of oxygen therapy, history of intensive care unit (ICU) stay,and hospitalization within first six months of life.[15-19]There is scanty literature on biosocial determinants of strabismus in the Indian population. Therefore, a study of these risk factors of strabismus in the Indian set-up is of immense public health importance.

In this hospital-based cross-sectional observational study, we analyzed the pattern and biosocial risk factors of concomitant strabismus among children and adolescents presenting to the Ophthalmic outpatient department (OPD) of a tertiary health care Institute in north India.

MATERIALS AND METHODS

This cross-sectional hospital-based study was done over 3 years from July 2017 to June 2020. The study adhered to the Declaration of Helsinki and clearance was taken from the Institutional Ethics Committee. All new patients attending Ophthalmic OPD between 4-19 years of age group were screened by a trained investigator after obtaining written informed consent. Patients with ≥ 7 ˚of deviation on Hirschberg corneal light reflex test or ≥ 15 Prism Dioptre (PD)of deviation on prism bar cover test were referred to a strabismus expert for final diagnosis. Written informed consent from at least 1 parent or guardian and the assent of each child was obtained before the examination.

Patients aged less than 4 years were excluded due to the fact that the children younger than 4 years are not very cooperative for strabismus evaluation. The upper limit of the age for study population was kept 19 years as WHO defines adolescents in the age group of 10-19 yrs. Further, patients with deviation <15 PD, not willing to participate or with incomplete data were excluded from the study. A total of 235 patients of strabismus were included in this study.

Patients were reassessed by Hirschberg corneal light reflex test, cover-uncover test, alternate cover test, prism bar

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Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

cover test and prism bar reflex test. All the patients underwent both dry retinoscopy and cycloplegic refraction under cyclopentolate 1% eyedrop/ atropine 1% eyeointment. The amount of deviation was assessed by prism bar cover test and prism bar reflex test with and without glasses.

Data were collected by a predesigned, pretested questionnaire which included questions regarding biosocial and natal factors such as age, geographical location, socioeconomic status, family history, and birth history, etc. The questionnaire was validated and pilot testing was done before initiating the data collection.

Data handling and statistical plan of analysis:

Data were entered in Microsoft Excel and analyzed using SPSS software for Windows. Mean and standard deviation was calculated for all the data. For comparisons of means, t-test was used and for proportions, the chi-square test was used. Pearson chi-square, likelihood ratio, Fisher's exact test and linear by linear association were calculated for the association between all the data.

RESULTS

A total of 235 patients were included in the study. The mean age of the group was 13.01± 5.71 years (Range = 4 - 19 years). The mean height and weight of the group were 133.89 ± 31.45 centimeters and 38.83± 18.83 kilograms respectively. Out of 235 patients, 126 (53.6 %) were male and 109 (46.4%) were female. The male: female ratio was 6:5. Out of 235 patients, 86 (36.6%) were esotropes, 124 (52.85%) were exotropes and 25 (10.6%) were in the miscellaneous group which included combined horizontal and vertical deviation with or without torsional deviation. The ratio of exotropia:esotropia was approximately 3:2.

Various biosocial risk factors of the study population in proportion analyses are shown in [Table1]. The obstetric history of the study population has been shown in [Table2]. Amongst all the biosocial determinants, there was a statistically significant association between the type of strabismus and age of the patient. According to age, patients were divided into 2 groups. Groups 1 and 2 included patients aged 4-9 years and 10-19 years respectively.Group 1 had 40 (46.5%) esotropes, 36 (29%) exotropes and 10(40%) patients of the miscellaneous group. Group 2 had 46 (53.5%) esotropes, 88 (71%) exotropes and 15 (60%) patients of the miscellaneous group (Fisher Exact value: 6.82; p =0.033). The above data shows that esotropia was more common in patients aged less than 10 years of age and exotropia and miscellaneous deviation were more common in patients aged 10-19 years.

Among female patients, 61 (49.2%) had exotropia, 39 (45.3%) had esotropia and 9 (36%) had a miscellaneous type of deviation, whereas 63 (50.8%) male patients had exotropia, 47 (54.7%) had esotropia and 16 (64%) had a

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Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

miscellaneous type of deviation. The gender of the patient had no statistically significant association with the type of strabismus (Pearson chi-square value: 1.51; p =0.45).

According to educational status, participants were divided into three groups. Group 1 included illiterate to below 8th class, Group 2 included 8th class to intermediate pass and Group 3 included graduation to post-graduation. Educational status of mother, and that of patient had no statistically significant association with type of strabismus. (p >0.05)

According to the occupational status, the participants were divided into three groups. Group 1 included unemployed/unskilled workers, Group 2 included semiskilled workers and Group 3 included professionals. There was no statistically significant association with the type of strabismus and occupational status of mother and father. (p>0.05) Socioeconomic status and religion had no statistically significant association with the type of strabismus. (p>0.05)

Only 18 (7.66%) patients had a family history of strabismus and all of them had exotropia.

Amongst the obstetric history, there was a statistically significant association between type of strabismus and birth weight, wherein 3(3.5%) of the esotropes, 2(1.6%) of the exotropes, and 3(12.0 %) of the miscellaneous group had a birth weight of <1500grams (Fisher Exact value: 5.90; p =0.04). If <2500 grams was taken as the limit for low birth weight, there was no significant association between low birth weight and type of strabismus. (Fisher exact value: 0.237;p=0.88).

There was also a statistically significant association between type of strabismus and illness requiring hospitalization and medical intervention within 6 months of birth. Fourteen (16.3%) of the esotropes, 6(4.8%) of exotropes and 1(4.0%) of the miscellaneous group had an illness within 6 months of birth that required hospitalization and medical intervention (Fisher Exact value: 8.02; p =0.015). A total of 13 patients were preterm out of which 10 were breastfed and 3 were top fed. There was no statistically significant association between prematurity and type of strabismus (Fisher's Exact Test: 7.96; p = 0.062). None of the patients had a history of maternal smoking during pregnancy, so it was not included in the final analysis.

There was no statistically significant association between place of delivery and type of strabismus. Out of 235 patients, 103(43.8%) patients were delivered at the hospital and the rest of the 132(56.2%) patients were delivered at home (Fisher Exact value: 2.285; p =0.307).

The person who conducted delivery also had no statistically significant association with the type of strabismus. Out of 235 patients, 113(48.10%) were delivered by a dai (a trained health care worker); 107(45.5%) were delivered by a doctor; 9(3.8%) were delivered by

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

nurse/midwife and rest of the 6(2.6%) were delivered by relatives (Fisher Exact value: 4.3988; p =0.62288).

According to the birth order, participants with first birth order included 50% of esotropes, 50% of exotropes and 48% of the miscellaneous type of deviation; those with second birth order included 31.4% of esotropes, 33.9% of exotropes and 20% of miscellaneous deviation, third-order born participants included 15.1% of esotropes, 8.9% of exotropes and 8% of the miscellaneous group. More than third birth order had 3.5% of esotropes, 7.3% of exotropes and 24% of miscellaneous deviation. There was no statistically significant association between birth order of patient and type of strabismus. (Fisher Exact value: 11.321; p =0.067).

Mode of delivery had no statistically significant association with the type of strabismus. The mode of delivery in 88.4% of esotropes, 89.5% of exotropes and 88% of the miscellaneous group was vaginal and in rest of the 11.6% of esotropes, 10.5% of exotropes and 12% of the miscellaneous group, the mode of delivery was Caesarean section (Fisher Exact value: 0.23; p =0.912).

Duration of gestation at the time of delivery, complications during pregnancy, birth asphyxia, intensive care unit stay of the patient, and history of oxygen therapy had no statistically significant association with the type of strabismus.

Table 1: Biosocial Determinants of Strabismus

Age(years)	N	%	Esotropia	Exotropia	Miscellaneous
4-9	86	36.6%	40(46.5%)	36(29.0%)	10(40%)
10-19	149	63.4%	46(53.5%)	88(71.0%)	15(60%)
Sex					
Male	126	53.6	47(54.7%)	63(50.8%)	16(64.0%)
Female	109	46.4	39(45.3%)	61(49.2%)	9(36.0%)
Educational status of the mother					
Below Class VIII	132	56.2	47(54.7%)	73(58.9%)	12(48.0%)
Till Intermediate	62	26.4	25(29.1%)	29(23.4%)	8(32.0%)
Postgraduate	41	17	14(16.3%)	22(17.7%)	5(20.0%)
Educational status of the father					
Below Class VIII	92	39.1	34(39.5%)	48(38.7%)	10(40.0%
Till Intermediate	85	36.2	33(38.4%)	43(34.7%)	9(36.0%)
Postgraduate	58	24.7	19(22.1%)	33(26.6%)	6(24.0%)
Educational status of the patient					
Below Class VIII	133	56.6	56(65.1%)	63(50.8%)	14(56.0%)
Till Intermediate	50	21.3	15(17.4%)	30(24.2%)	5(20.0%)
Postgraduate	52	22.1	15(17.4%)	31(25.0%)	6(24.0%)

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

Occupation of father					
Unemployed/unskilled	62	26.4	22(25.6%)	33(26.6%)	7(28.0%)
Semiskilled	116	49.4	46(53.5%)	61(49.2%)	9(36.0%)
Professional	57	24.3	18(20.9%)	30(24.2%)	9(36.0%)
Occupation of mother					
Unemployed/unskilled	220	93.6	84(97.7%)	114(91.9%)	22(88.0%)
Semiskilled	4	1.7	0(0.0%)	3(2.4%	1(4.0%)
Professional	11	4.7	2(2.3%	7(5.6%)	2(8.0%)
Socioeconomic status					
Below Poverty Line card holder	24	10.2	5(5.8%)	17(13.7%)	2(8.0%)
Above Poverty Line card holder	27	11.5	7(8.1%)	15(12.1%)	5(20.0%)
None	184	78.3	74(86.0%)	92(74.2%)	18(72.0%)
Religion					
Hindu	176	74.9	69(80.2%)	93(75%)	14(56.0%)
Muslim	37	15.7	13(15.1%)	21(16.9%)	3(12.0%)
Others	22	9.4	4(4.7%)	10(8.1%)	8(32%)

Table 2: Obstetric History

Birth order	**N**	**%**	**Esotropia**	**Exotropia**	**Miscellaneous**
First	117	49.8	43(50.0%)	62(50.0%	12(48.0%)
Second	74	31.5	27(31.4%)	42(33.9%)	5(20.0%)
Third	26	11.1	13(15.1%)	11(8.9%)	2(8.0%)
More than third	18	7.7	3(3.5%)	9(7.3%)	6(24.0%)
Type of delivery					
Vaginal	209	88.9	76(88.4%)	111(89.5%)	22(88.0%)
Caesarean section	26	11.1	10(11.6%)	13(10.5%)	3(12.0%)
Place of delivery					
Home	132	56.2	43(50.0%)	73(58.9%)	16(64.0%)
Hospital	103	43.8	43(50.0%)	51(41.1%)	9(36.0%)
The person who conducted delivery					
Dai (Trained Health Care Worker)	113	48.1	46(53.5%)	59(47.6%)	8(32%)
Doctor	107	45.5	36(41.9%)	56(45.2%)	15(60%)
Nurse/ANM/midwife	9	3.8	3(3.5%)	5(4.0%)	1(4.0%)
Relative	6	2.6	1(1.1%)	4(3.2%)	1(4.0%)
Duration of gestation at the time of delivery					
Term	217	92.3	78(90.7%)	118(95.2%)	21(84.0%)
Preterm	13	5.5	4(4.7%)	5(4.0%)	4(16.0%)
Post term	5	2.1	4(4.7%)	1(0.8%)	0(0.0%)
Any complication during pregnancy					
No	227	96.6	84(97.7%)	121(97.5%)	22(88.0%)
Yes	8	3.4	2(2.3%)	3(2.4%)	3(12.0%)
Birth asphyxia					

Annals of International Medical and Dental Research
E-ISSN: 2395-2822 | P-ISSN: 2395-2814
Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

Patient immediately cried after birth	216	91.9	78(90.7%)	115(92.7%)	23(92.0%)
Patient did not cry immediately after birth	19	8.1	8(9.3%)	9(7.3%)	2(8.0%)
Birth weight (Grams)					
<1500	8	3.4	3(3.5%)	2(1.6%)	3(12%)
>1500	227	96.6	83(96.5%)	122(98.4%)	22(88%)
Birth weight (Grams)					
<2500	185	78.7	67(77.9%)	99(79.8%)	19(76%)
>2500	50	21.3	19(22.1%)	25(20.2%)	6(24%)
Intensive care unit stay					
No stay	213	90.6	75(87.2%)	116(93.5%)	22(88.0%)
<1 week stay	10	4.3	5(5.8%)	3(2.4%)	2(8.0%
> 1week stay	12	5.1	6(7.0%)	5(4.0%)	1(4.0%)
Oxygen therapy					
No	215	91.5	77(89.5%	116(93.5%)	22(88.0%)
Yes	20	8.5	9(10.5%)	8(6.5%)	3(12.0%)
Illness requiring hospitalization within 6 months of birth					
No	214	91.1	72(83.7%)	118(95.2%)	24(96.0%)
Yes	21	8.9	14(16.3%)	6(4.8%)	1(4.0%)

DISCUSSION

This study was conducted in a tertiary health care Institute;therefore,the prevalence rate of strabismus was not assessed because of the high possibility of overestimation of the same.

In contrast to the previous studies by Akpe et al, Yu et al. and Mohneyet al.[20-22] our study population had male preponderance for strabismus (male: female ratio of 6:5). However, there was no statistically significant association between gender and type of deviation (Pearson chi-square value: 1.515; p =0.453).

As risk factors of strabismus, biosocial factors, and ethnicity vary in different countries, their association with strabismus is also expected to vary. Exotropia is more prevalent than esotropia in Brazil, Singapore, Cameroon, Baltimore (USA), Arizona (USA), China, Japan, South India, and Hong Kong.[21,23-30] Whereas, esotropia is more prevalent in the United Kingdom, Minnesota(USA), Nigeria, Pakistan, Tanzania, Sudan and Ethiopia.[20,31-36]

According to Rachael et al., countries with higher intensity of sunlight have exotropia as the more prevalent form of strabismus.[37]In concurrence with this hypothesis, in our study population, 124 (52.85%) were exotropes, 86 (36.6%) were esotropes, and the ratio of exotropia: esotropia was approximately 3:2.

In this study esotropia was more common in children (4-9 years of age) whereas exotropia and miscellaneous type of deviation were more common

Annals of International Medical and Dental Research
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Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

in adolescents (10-19 years of age). (Fisher Exact value: 6.823; p =0.033). This is suggestive of relatively late presentation of exotropes to the ophthalmic OPD, most probably because of the intermittent nature of exodeviation in initial years of presentation due to good fusional convergence at a younger age.

There are conflicting reports about associations between socioeconomic variables and strabismus. According to Singaporean Preschoolers Study (STARS),[38] higher paternal education was associated with a protective effect against strabismus and in the Millennium Cohort Study of UK , children and socioeconomic status was inversely associated with strabismus;[39] however, Sydney Myopia Study (SMS), Avon Longitudinal Study of Parents and Children (ALSPAC), Multi-Ethnic Pediatric Eye Disease Study (MEPEDS), and Baltimore Pediatric Eye Disease Study (BPEDS) concluded that parental education, monthly income, and house ownership were not associated with strabismus.[1,2,38,40]

Similarly, in our study the educational status of mother, father, and patient, occupation of mother and father, socioeconomic status, religion and caste had no statistically significant association with the type of strabismus.
The type of deviation in strabismus patients is significantly determined by prematurity, low birth weight, and a family history of strabismus.[38,40] Only 13 (5.53%) patients in our study had a history of preterm delivery, 22 (9.36%) had a history of ICU stay and 21 (8.93%) had a history of hospitalization within six months of birth.
A total of 8 (3.40%) patients had a history of birth weight < 1500 grams, and 185 (78.72%) had a history of birth weight <2500 grams. There was a statistically significant association between type of strabismus (esotropia and miscellaneous type of deviation) and birth weight <1500grams (Fisher Exact value: 5.90; p =0.046), whereas there was no such association if <2500 grams was taken as the limit for low birth weight (Fisher exact value: 0.237; p=0.888).

According to SMS, prematurity, low birth weight (<2500 grams), and admission to the intensive care unit,conferred a 3- to 5-fold increase in the odds of both esotropia and exotropia.[2] The results of our study were in concurrence with those of the above study as there was no statistically significant association between these three parameters and the type of strabismus.

However, there was a statistically significant association between type of strabismus (esotropia) and illness within 6 months of birth that required hospitalization and medical intervention (Fisher Exact value: 8.02; p=0.015).

According to MEPEDS and BPEDS, a family history of strabismus was associated with a 2-fold increased risk of exotropia [40]. Only 18 (7.66%) patients in our study had a family history of strabismus and all of them

Annals of International Medical and Dental Research
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Vol-7, Issue-3 | May-June, 2021
Page no- 210-220 | Section- Research Article (Ophthalmology)

were exotropes which is in concurrence with the results of the above studies.

In developing countries like India, most of the deliveries are still being conducted by trained health care workers (or dais) at home. In our study, a significant number of patients (113, 48.10%) had a history of delivery conducted by a trained dai, and 132 (56.20%) were born at home. However, there was no statistically significant association between the person who conducted delivery and the place of delivery with the type of strabismus.

Further, birth order, mode of delivery, duration of gestation at the time of delivery, complications during pregnancy, birth asphyxia, and history of oxygen therapy had no statistically significant association with the type of strabismus.

Several previous studies have reported a significant relationship between strabismus and maternal smoking during pregnancy. [15,16,19] In our study none of the patients had a history of maternal smoking during pregnancy, so it was not included in the final analysis.

The main strength of our study was the standardized examination protocol and each patient was examined by a strabismus expert. Cover-uncover test and prism cover tests were done for every patient, therefore those with a latent component of deviation were not missed.

Single centre hospital based cross-sectional study design was the limitation of the study, due to which we could not estimate the prevalence of strabismus. We were unable to report any possible association between maternal smoking during pregnancy and the type of deviation. However, a population-based study with a larger sample size can be planned based on the results of this study.

CONCLUSION

Thus, we can conclude that in our study, there was male preponderance, and exotropia was more prevalent than esotropia. However, patients with exotropia presented to Ophthalmologists later (10-19 years) than those with esotropia (4-9 years). Birth weight <1500 grams and illness requiring hospitalization within 6 months of birth had a statistically significant association with the type of strabismus. The rest of the biosocial factors had no such association with the type of strabismus.

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