

# Prevalence of intermittent exotropia among primary and secondary school students in Shantou, China

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**Background:** Few prevalence studies on intermittent exotropia (IXT) based on Chinese populations. Furthermore, longitudinal change in this pattern within a local setting has not been reported in the past. This study aims to determine the profile of children with IXT in China.

**Methods:** A total of 7,537 subjects from nine multi-layer primary and secondary schools participated in this investigation. The position of eyes was examined by using Hirschberg test and alternate cover test. The obtained results were classified according to respective features and analyzed statistically.

**Results:** The prevalence of IXT among the participants was 7.98%, accounting for 73.04% of all types of strabismus. Junior high school students had a lower prevalence of IXT than elementary and senior high school counterparts. Logistic regression analysis showed that IXT was mainly found in male pupils at high grades in rural areas and in male secondary students at high grade in urban regions.

**Conclusions:** IXT was shown to be more prevalent than other types of strabismus in Chinese children. Furthermore, the distribution and characteristics of IXT greatly varied among participants.

**Keywords:** Intermittent exotropia (IXT); students; survey

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## Introduction

Intermittent exotropia (IXT), as a fairly common condition, is a transition strabismus between exophoria and constant exotropia (1). It is the most prevalent form of childhood exotropia and constantly affects binocular vision and easily evolves into constant exotropia (2). IXT occurs in approximately 1% of developmentally healthy children in the United States (2). But few large-scale studies on non-white populations are available.

In this study, children presenting with IXT were assessed. The types of strabismus and characteristics such as age, Area of residence, gender, and grade were determined.

## Methods

### *Study subjects*

Two categories of schools were identified according to Shantou Education Bureau: urban and rural (with most of the population working in agriculture) (*Table 1*). There were 302 public schools in Shantou three district (namely: Jinping, Longhu, Chenghai): 81 elementary, 51 middle, 38 high schools in urban, and 59 elementary, 41 middle, 32 high schools in rural respectively. Five schools (three primary, one middle and one high school) from urban and four schools (two primary, one middle and one high school) from rural were selected randomly for a total of nine

**Table 1** Demographic information of participants in a population study of strabismus in Shantou district, China

Characteristics	Total No. (%)	Completing testing (%)
Age (years)		
6–8	2,462 (32.7)	2,440 (32.7)
9–11	2,657 (35.3)	2,636 (35.3)
12–14	1,235 (16.4)	1,227 (16.4)
15–17	1,183 (15.7)	1,161 (15.6)
Sex		
Male	3,968 (52.7)	3,928 (52.6)
Female	3,569 (47.4)	3,536 (47.4)
Area of residence		
Urban	4,304 (57.1)	4,269 (57.2)
Rural	3,233 (42.9)	3,195 (42.8)
Total	7,537	7,464

schools. School sizes ranged from 800 to 1,000 students for the primary schools and 500 to 700 students for the middle and high schools. In China, school attendance is compulsory for 9 years (6 years of primary school and 3 years of middle school). Therefore, the sample is likely to be representative of the population in the age range of 6 to 17 years. Students provided verbal consent, and their legal guardians provided written consent. This study was approved by the Ethics Committee of the Joint Shantou International Eye Center and was conducted in accordance with the Declaration of Helsinki.

### Ocular examination

All participants underwent a complete strabismus examination by certified ophthalmologists who specialize in pediatric eye care. Ocular alignment was measured by Hirschberg testing, unilateral cover (cover-uncover) testing (UCT), and alternate cover testing (ACT) of standardized duration, at 6-m and 40-cm fixation, without correction.

### Definitions and criteria for strabismus

The strabismus classification method approved by National Workshop of Prevention and Control of Amblyopia and Strabismus in Children held in 1996 was adopted in this study (1). A patient with strabismus showed constant or intermittent tropia of any magnitude at distance or near fixation. A patient with orthophoria showed no deviation

during Hirschberg testing and no eye movement during UCT or ACT. A patient with esophoria or exophoria showed a horizontal shift during ACT and no movement of the uncovered eye during UCT, respectively. A patient with IXT presented no deviation during Hirschberg testing and no eye movement of the uncovered eye during UCT, but exodeviation after prolonged ACT. A patient with exotropia or esotropia exhibited exodeviation or esodeviation, respectively, during Hirschberg testing, as confirmed by UCT and ACT. In no case did the direction of the strabismus change between UCT and ACT or between near and distance.

### Statistical analysis

Excel software was used to establish the database, SPSS 15.0 statistical software was utilized to analyze data. Unoriginal categorical variables were analyzed by  $\chi^2$  test, and  $\chi^2$  value was divided from degree of freedom. The probability was calculated by binomial distribution method. Line graph was adopted to represent the change tendency of the prevalence of strabismus as different grades and show the differences between rural and urban students. Multi-factorial logistic regression models were used to analyze the association between confounding factors and IXT;  $\alpha=0.05$  was considered as a level of significance.

### Results

After informed consents were obtained, a total of 7,464 participants (99.03%), including 3,928 males and 3,536 females, underwent eye examinations. The composition of various types of strabismus among all participants was shown in Table 2. The prevalence of IXT achieved 7.89% in this survey, accounting for 73.04% of all types of strabismus. The results showed that rural pupils had a significantly higher prevalence of IXT than their counterparts living in urban areas ( $\chi^2=7.625$ ,  $P=0.006$ ), while students at rural senior high schools showed a significantly lower prevalence of IXT compared with those at urban senior high schools ( $\chi^2=11.161$ ,  $P=0.001$ ). No statistical significance was noted between rural and urban junior high school students regarding the prevalence of IXT ( $\chi^2=2.243$ ,  $P=0.134$ ).

In rural areas, statistical significances were found among students at different grades ( $\chi^2=38.021$ ,  $P=0.000$ ). Any two types of schools differed in the prevalence of IXT ( $\chi^2=5.951-35.077$ ;  $P=0.015-3.17\times 10^{-9}$ ). The most pronounced difference was noted among primary schools, followed

**Table 2** Composition of various types of strabismus among primary and secondary school students from Shantou

Type	Primary school			Secondary school			Total
	Rural	Urban	Total	Rural	Urban	Total	
Normal eye position	493 (23.91)	767 (25.44)	1,260 (24.82)	294 (26.02)	337 (26.79)	631 (26.42)	1,891 (25.33)
Exophoria	1,187 (57.57)	1,816 (60.25)	3,003 (59.16)	753 (66.64)	771 (61.29)	1,524 (63.82)	4,527 (60.65)
Esophoria	96 (4.66)	97 (3.22)	193 (3.80)	19 (1.68)	18 (1.43)	37 (1.55)	230 (3.08)
IXT	212 (10.28)	242 (8.03)	454 (8.94)	51 (4.51)	91 (7.23)	142 (5.95)	596 (7.98)
Constant exotropia	63 (3.05)	88 (2.92)	151 (2.97)	12 (1.06)	39 (3.10)	51 (2.14)	202 (2.71)
Concomitant esotropia	10 (0.48)	2 (0.07)	12 (0.24)	1 (0.09)	1 (0.08)	2 (0.08)	14 (0.19)
Others	1 (0.05)	2 (0.07)	3 (0.06)	0 (0.00)	1 (0.08)	1 (0.04)	4 (0.05)
Total	2,062 (100.00)	3,014 (100.00)	5,076 (100.00)	1,130 (100.00)	1,258 (100.00)	2,388 (100.00)	7,464 (100.00)

IXT, intermittent exotropia.

**Table 3** Comparison on the prevalence of IXT in pupils among different areas and grades from Shantou

Grade of primary school	Rural areas			Urban areas			P
	Number	IXT (n)	Prevalence of IXT (%)	Number	IXT (n)	Prevalence of IXT (%)	
1	351	31	8.83	464	30	6.47	0.204
2	371	37	9.97	419	19	4.53	0.003
3	337	37	10.98	498	28	5.62	0.005
4	338	39	11.54	557	43	7.72	0.055
5	377	39	10.34	540	60	11.11	0.713
6	288	29	10.07	536	62	11.57	0.513
Total	2,062	212	10.28	2,014	242	8.03	0.006

IXT, intermittent exotropia.

by junior middle and senior middle schools. In urban regions, significant differences were noted among students at various grades ( $\chi^2=55.074$ ,  $P=0.000$ ). Any two types of schools differed in the prevalence of IXT ( $\chi^2=14.365-57.886$ ,  $P=1.51 \times 10^{-4}-2.78 \times 10^{-14}$ ). The most striking difference was observed among junior high schools followed by primary and senior high schools. Among all participants, senior high school students had the highest prevalence of IXT. In rural areas, pupils showed the highest prevalence of IXT.

The prevalence of IXT among all participants differed ( $\chi^2=70.627$ ,  $P=0.000$ ). Junior high school students differed from those combined from primary and senior high schools regarding the prevalence of IXT ( $\chi^2=68.978$ ,  $P=0.000$ ), suggesting that junior high school students had a lower prevalence of IXT than those at primary and senior high

schools, respectively.

Comparison on the prevalence of IXT among primary school students at various grades was shown in *Table 3*. There was no significant difference among rural primary school students at various grades regarding the prevalence of IXT ( $P=0.1954-0.2126$ ). In urban regions, primary school students in grade 5 and 6 had a relatively high prevalence of IXT ( $P=0.0047$  and  $0.0017$ ), and students at grades 2 and 3 showed a relatively low prevalence of IXT ( $P=0.0033$  and  $0.0247$ ). To sum up, the prevalence of IXT in primary students living in rural areas was significantly higher than that of their urban counterparts ( $\chi^2=7.625$ ,  $P=0.006$ ). *Table 3* showed the changes of the prevalence of IXT over grades. The prevalence of IXT of pupils in urban areas increased over grade ( $r=0.869$ ,  $P=0.025$ ;  $r_s=0.829$ ,

**Table 4** Comparison on the prevalence of IXT in secondary students among different areas and grades from Shantou

School	Grade	Rural			Urban			P
		Number	IXT (n)	Prevalence of IXT (%)	Number	IXT (n)	Prevalence of IXT (%)	
Junior high school	1	230	8	3.48	212	3	1.42	0.164
	2	180	4	2.22	182	2	1.10	0.403
	3	214	5	2.34	209	4	1.91	0.763
	Total	624	17	2.72	603	9	1.49	0.134
Senior high school	1	192	9	4.69	208	25	12.02	0.009
	2	162	8	4.94	228	45	19.74	0.000
	3	152	17	11.18	219	13	5.94	0.068
	Total	506	34	6.72	655	83	12.67	0.001
Total		1,130	51	4.51	1,258	92	7.31	0.004

IXT, intermittent exotropia.

$P=0.042$ ), while no apparent correlation was noted between the prevalence of IXT and grade in those living in rural parts ( $r=0.452$ ,  $P=0.386$ ;  $r_s=0.486$ ,  $P=0.329$ ).

Comparison of the prevalence of IXT in middle school students at various grades was indicated in *Table 4*. In rural regions, junior students at different grades had the similar prevalence of IXT ( $P=0.708$ ). In senior high schools, grades 1 and 2 students had the similar prevalence of IXT ( $P=1.000$ ). The prevalence of the overall group of grades 1 and 2 students was lower than that of grade 3 students ( $P=0.012$ ); the prevalence of IXT in junior high school students was lower compared with that of senior high school students ( $\chi^2=10.348$ ,  $P=0.001$ ). In urban areas, the prevalence of IXT among junior students of all grades did not differ significantly ( $P=0.8441$ ); grade 2 students in senior high schools had a relatively high prevalence of IXT ( $P=0.0009$ ) and those at grade 3 showed a relatively low prevalence of IXT. However, students at senior high schools had a higher prevalence of IXT than their counterparts at junior high schools ( $\chi^2=57.886$ ,  $P=0.000$ ). No correlation was noted between age and the prevalence of IXT in high school students in urban regions ( $r=0.633$ ,  $P=0.178$ ;  $r_s=0.771$ ,  $P=0.072$ ) while certain correlation was found in those from rural areas ( $r=0.789$ ,  $P=0.062$ ;  $r_s=0.829$ ,  $P=0.042$ ).

Correlation between confounding factors and the prevalence of IXT was analyzed by Logistic regression models (*Table 5*). For pupils, the prevalence of IXT was correlated with sex, grade, place of origins (urban/rural) rather than age. The pupils in rural areas had a relatively high prevalence of IXT. For high school students, similar

results were obtained. The male students at high grade in urban areas had a relatively high prevalence of IXT.

## Discussion

IXT is a type of strabismus between exophoria and constant exotropia (1). The patients are able to maintain normal eye position and binocular vision most of the time, while present with exotropia when failing to concentrate or seeing distant objects. As exotropia progresses in the frequency and duration, along with the decreased fusional and accommodative capacities, the patients eventually present with a variety of exotropia symptoms. In most population-based strabismus investigations (3-8) by Western countries, the prevalence of esotropia was twice as high as exotropia. However, the prevalence of exotropia is twice of that of esotropia in Asian population (9-11). A retrospective study from Hong Kong (12), including 2,704 patients with strabismus reported that 27.4% cases of esotropia, 20.3% of constant exotropia and 44.9% of IXT. Chia *et al.* (13) retrospectively analyzed a total of 493 children with strabismus aged below 16 years and found that 72% cases were exotropia, 92% of whom developed IXT. However, there are few population-based studies focusing on the epidemiology of strabismus in Asia. He *et al.* (9) conducted a survey of 4,364 participants aged from 5 to 15 years and noted that the prevalence of strabismus was 1.9% when looking at near, 3.0% when looking at distance and 80% cases were exotropia. Zhao *et al.* (10) analyzed a total of 5,884 children aged between 5 to 15 years from Shunyi District, Beijing City and found that the prevalence of

**Table 5** Analysis of the correlation between confounding factors and IXT by logistic regression model

School	Factors	b	SE (b)	P	OR	95% CI for OR	
						Lower	Upper
Primary school	Age	-0.001	0.036	0.987	0.999	0.932	1.072
	Gender	0.311	0.114	0.006	1.365	1.093	1.706
	Grade	0.329	0.052	0.000	1.389	1.254	1.539
	Area of residence	-0.248	0.114	0.030	0.780	0.625	0.976
	Infinite terms	-2.019	0.333	0.000	0.133	-	-
Secondary school	Age	-0.081	0.095	0.391	0.922	0.766	1.110
	Gender	0.300	0.142	0.035	1.349	1.022	1.782
	Grade	0.441	0.118	0.000	1.555	1.235	1.957
	Area of residence	0.749	0.254	0.003	2.114	1.285	3.478
	Infinite terms	-1.793	1.267	0.157	0.167	-	-

Note: response variable and normal eye position =0; age (year); gender: female =0 and male =1; place of origin: rural areas =0 and urban areas =1; grade: 1,2,3,4,5,6. IXT, intermittent exotropia; OR, odds ratio; SE, standard error.

strabismus was 2.8% (165/5884). However, both studies did not analyze the types of strabismus or report the prevalence of IXT. In current study, 8% of 7,464 participants had IXT, accounting for 73.04% of all children with strabismus. The prevalence of IXT was significantly higher than that of constant strabismus, while IXT mainly arises from the imbalance between exodeviation and convergence due to convergence and fusion insufficiency. Especially, the myopic patients with declined accommodative convergence are more likely to develop IXT. Therefore, previous studies (14,15) have confirmed the correlation between the prevalence of IXT and myopia. The authors will perform correlation analysis between strabismus and ametropia.

This survey indicated that pupils and senior middle school students showed a higher prevalence of IXT compared with junior middle school counterparts, which might be the results of the deteriorated fusion capacity induced by myopia for senior high school students. Moreover, pupils in rural schools had a greater prevalence of IXT than those in urban areas possibly associated with the understanding of and emphasis on IXT of their parents and medical services available in rural schools (history of disease was not investigated). For students in villages, junior middle school students had the greatest prevalence of IXT, followed by primary and senior high school students. However, for participants from urban areas, junior middle school students had the highest prevalence of IXT, followed by primary and senior high school counterparts. Overall, junior high school students had a higher prevalence of IXT

than both the primary and senior high school counterparts, respectively. A survey (14) analyzing eye position of 636 Japanese with high myopia found that 13.4% of cases had exotropia while looking at near and 8.8% had concomitant exotropia while gazing at distance, significantly higher than 4.9% and 4.7% of esotropia cases. A U.S. survey (15) regarding IXT revealed that 90% of IXT population developed myopia. Therefore, it is presumed that increasing prevalence of myopia, decreasing accommodation function of both eyes and the time and suitability of wearing glasses are likely to affect the epidemiological features of strabismus, especially IXT.

In this survey, the correlation between confounding factors and the prevalence of IXT was investigated. The results showed that, for pupils, the prevalence of IXT was correlated with sex, grade and place of origins rather than age. In addition, male pupils at high grades in rural areas had a relatively high prevalence of IXT. For secondary school students, the prevalence of IXT was not correlated with age, but associated with sex, grade and place of origins. Male secondary students at high grades in urban areas had a relatively higher prevalence of IXT than the other subjects. Logistic regression analysis revealed that IXT had a greater prevalence in males than females. Correlation analysis of grade and place of origins showed that the students at senior high schools in urban areas and the pupils in rural regions had a high prevalence of IXT.

It should be noted that current survey also has certain limitations that the correlation between ametropia/corrected

vision and eye position is not analyzed, which is helpful to explain the epidemiological distribution of IXT.

## Conclusions

In conclusion, the prevalence of IXT among student populations were relatively high. The distribution pattern of IXT greatly varied among primary, junior high and senior high school students and between those from rural and urban regions.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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