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IN THIS ISSUE

- GAVI, the Vaccine Alliance's Contribution to Nigeria
- Stress and Cardiovascular Risk in University Staff
- 60- and 90-seconds sitting versus immediate supine positioning
- Absenteeism among in-school adolescents
- Prevalence and Patterns of Strabismus
- HRQOL in children with HIV
- Therapeutic Evaluation of Lithium Chloride Against Malaria
- Immediate versus Early Oral Feeding following Uncomplicated CS
- Contextual Determinants of Repeat Unintended Pregnancy
- Knowledge of diabetes mellitus and its explanatory predictors

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ORIGINAL RESEARCH

Prevalence and Patterns of Strabismus Among In-School Adolescents in Sagamu, Southwest Nigeria

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Abstract

Background: Strabismus (squint) may be a cause of uniocular or binocular preventable visual impairment. It is one of the ocular conditions that ophthalmologists meet in clinical practice, especially in the paediatric age group.

Objectives: To determine the prevalence and patterns of strabismus among in-school adolescents in Sagamu, South-west Nigeria.

Methods: A population-based cross-sectional analytical study was conducted among 2750 in-school adolescents aged 10-19 years selected using a multi-stage sampling technique. Data were collected using a semi-structured self-administered questionnaire, Snellen's chart and ophthalmoscope. Descriptive and inferential statistics were calculated with the level of significance (P) set at 0.05. Informed consent and assent were obtained from study participants and their parents as appropriate.

Result: The mean age of participants was 13.57 ± 2.22 years, with a male-to-female ratio of 1:1.3. The self-reported prevalence of strabismus was 6%, but following ocular examination, a prevalence of 0.4% was found. The most common angle of strabismus was less than or equal to 15PD (33.3%). Of these, esotropia accounted for 58.3%, while 33.3% had exotropia, and 8.3% had hypotropia. Strabismus was associated with refractive error ($p=0.00$), but no association was found with socio-demographic factors.

Conclusion: The prevalence of strabismus was low (0.4%), with esotropia being the most common type. Pre-school screening will help to identify those with strabismus early.

Keywords: *Adolescents, Esotropia, Exotropia, Prevalence, Strabismus.*

Introduction

The term strabismus is derived from the Greek word *strabismos*—“to squint, to look obliquely or askance”—and means ocular misalignment.^[1] This misalignment may be

caused by abnormalities in binocular vision or anomalies of neuromuscular control of ocular motility.^[1,2] Strabismus is a common condition worldwide, which affects all age

groups, and there is no sex predilection.^[1] Globally, the prevalence of strabismus is low and varies in different regions of the world.^[3] Its prevalence worldwide varies from 0.8% to 5.7% in children, although a study among Asians revealed a lower prevalence of 0.7% to 1.9%.^[4,5] The prevalence in African populations ranged from 0.2% to 2.4%, whereas in Nigeria, it is 0.01-2.4% for population-based studies.^[6,7]

Strabismus is a significant cause of ocular morbidity, such as diplopia, which occurs because the fixation object is being imaged onto the fovea of one eye and a non-foveal region of the misaligned eye.^[1] Amblyopia is a developmental disorder of the central nervous system due to the abnormal processing of visual images, which leads to reduced visual acuity and has been associated with strabismus.^[1,2] About forty per cent of patients with manifest strabismus develop amblyopia.^[8]

There are several methods of classifying ocular alignment and motility disorders, but none is perfect or all-inclusive.^[1,9] Strabismus may be classified as latent (phoria) or manifest (tropia), and as comitant or noncomitant,^[10] while the deviation of the eyes may present as esodeviation, exodeviation, hyperdeviation, or hypodeviation.^[2] The diagnosis of strabismus is clinical,^[1] and evaluation begins with a detailed history covering onset, progression, associated factors, pregnancy and perinatal events, as well as any family history of strabismus.^[6,7] This is followed by an ocular examination, starting with an age-appropriate assessment of visual acuity without and with correction or

pinhole in each eye, measurement of the angle of strabismus with Hirschberg and prism tests, adequate cycloplegic refraction, and a detailed examination of the anterior and posterior segments of the eye.^[1,2] Strabismus is treatable; early detection is important for both the restoration of normal ocular alignment and the establishment of binocular single vision at an early age, which are the key determinants of outcome.^[1,11]

This study aimed to determine the prevalence, patterns and angle of strabismus among in-school adolescents in Sagamu, South-west Nigeria. It also considered socio-demographic factors that may be associated with strabismus in the participants. This is pertinent because strabismus affects vision, which can also affect career choice and in-school adolescents are at the stage of making great career choices. Intensive health education of students, parents, and teachers about strabismus is necessary to encourage early presentation and prompt referral of affected students.^[10]

Methods

Study Design and Location: This is a population-based cross-sectional analytical study conducted among in-school adolescents in Sagamu township, in Sagamu Local Government (LGA), one of the twenty LGAs of Ogun State, South-west Nigeria.^[12] The study was conducted from 18th August 2021 to 10th March 2022.

Definition of Terms

An adolescent is a juvenile between the onset of puberty and maturity, aged 10 through 19 years (WHO), and is also referred to as a teenager. Adolescence classification into three groups: early adolescence (10-13 years), middle adolescence (14-16 years) and late adolescence (17-19 years).

Secondary school is an educational institution which is intermediate between elementary or primary school and college or tertiary school (University).^[14]

Ethical considerations: Ethical approval was obtained from the Olabisi Onabanjo University Teaching Hospital Health Research Ethics Committee (OOUTH-HREC/327/2020AP), permission was granted by the Ogun State Ministry of Education, Science and Technology through the Zonal Education Officer of Sagamu LGA, Department of Planning, Research and Statistics, Principals, and teachers at the selected schools.

Informed consent: Parental informed consent was obtained before the commencement of this study, and assent was obtained from adolescents less than 18 years of age. Written informed consent was obtained from participants aged 18 years and above, and the study was conducted in accordance with ethical principles.

Study Participants: Adolescents attending public and private secondary schools in Sagamu LGA of Ogun State. Sagamu township had a total of 56,233 students

within twenty-two public secondary schools of 35,165 students (63%) and fifty-two private schools with 21,068 students (37%).^[13]

Inclusion and exclusion criteria: All registered adolescents (aged 10-19 years) attending selected public and private secondary schools in Sagamu township. Dissenting students or those whose parents refused to sign the consent form were excluded.

Sample size calculation: The sample size was calculated using Fisher's formula

$$n = Z^2 Pq/d. \quad [15]$$

Where n = sample size, Z = level of confidence at 95% i.e, 1.96, P = expected prevalence 2.4%.^[16] d = precision i.e, degree of accuracy, $q=1-p$.

The attrition rate was set at 10%. Therefore, total sample size was 2750 students

Sampling technique: A multi-stage random sampling technique was used to select participants.

Stage 1: This involved the selection of six wards out of the twelve (12) wards within Sagamu township by balloting (50%), using simple random sampling. The six wards selected were wards 1-5 and ward 15.

Stage 2: This involved the stratification of schools in each selected ward into public and private schools, which was done with the list obtained from the Ministry of Education, Science, and Technology. In

Prevalence and Patterns of Strabismus

Ogun State, there are 511 public secondary schools with 445,742 students (55%) and 1705 private secondary schools with 358,155 students (45%). These schools are distributed unevenly within the various wards in Sagamu township. The choice of six public and six private secondary schools within the pre-selected six wards was by simple random sampling through balloting (twelve schools were selected in total).

Stage 3: This involved the proper allocation of participants from the selected schools using a proportionate sampling technique. One thousand six hundred and twenty-nine (1,629) students from the public schools (271 each from three public schools & 272 each from three private schools) and one thousand one hundred and twenty-one (1,121) students from the private schools.

Stage 4: The class registration was used to select every third student from the first two arms (class A & B) of each class J.S.S 1-S.S.S 3 from public schools and every student from the first two arms (class A&B) of private schools, or the total number of students were selected based on the number of students in the private school. The examination was done in the school hall or inside the classroom when the school hall was not available.

Pre-test/ reliability and validity of the research instrument: A one-day training programme was organised for the research assistants (5 resident doctors and 2 ophthalmic nurses) on what the study was about, how to organise the students during screening in the school, consent form and

questionnaire administration and visual acuity assessment.

Pre-survey activities were organised for the research team on the logistics of the study, how to obtain credible information and data, while the questionnaire was pre-tested on in-school adolescents in a contiguous LGA (Ikene) to the study site.^[12] The participants who required treatment were offered appropriate treatment at Kesington Adebukunola Adebutu Foundation (KAAF) Eye Centre, OOUTH, Sagamu.

Study procedure: The research team comprised the principal investigator, resident doctors and ophthalmic nurses per school screening. The resident doctor gave and collected the consent form and the questionnaire, the ophthalmic nurse checked the visual acuities, and the principal investigator performed the ocular examination for all the participants.

A semi-structured self-administered questionnaire was used. The questionnaire was filled out by the participants, aided by their parents/guardians, and recorded the socio-demographic data and relevant history of strabismus. All the participants filled sections A and B of the questionnaire at home in the company of their parents or guardians. The principal investigator filled in section C of the questionnaire. The survey team examined about fifty (50) participants per day in the selected schools. Visual acuities and ocular examinations were performed using an array of ophthalmic instruments, including Snellen's charts, near reading charts, pen torches, prisms, trial lens boxes, slit lamp biomicroscopes,

cyclopentolate, binocular indirect ophthalmoscopes, Heine streak retinoscope, Titmus fly test and Worth 4 dot test.

Visual acuity measurement: Visual acuity (VA) for distance was done for all selected students in the school with the Snellen's acuity chart at 6 metres (6m) with and without corrections and/or Pinhole, near vision check was done at 33 centimetres (33cm) in each eye.

Strabismus assessment: Hirschberg's test (corneal light reflex) and cover-uncover test were performed on all participants to determine the presence and type of strabismus (e.g., temporal displacement of the corneal reflex suggests esotropia, and nasal displacement suggests exotropia, etc.). These were performed at school.

Participants with strabismus and those with VA $\leq 6/12$ or ocular abnormality were referred to the KAAF Eye Centre, OOUTH, for detailed examination and management. Those with strabismus had a comprehensive eye examination, including the Prism cover test and Krimsky test to find the angle of the strabismus. The prism cover test was done by holding a prism over the deviating eye for near vision, focusing on a near target and for distance, focusing on Snellen's chart. The endpoint is when no movement is seen, and the angle of deviation then equals the strength of the prism. Sensory tests, i.e., Titmus fly, and Worth's 4 dot test were done to detect stereopsis and suppression for the participants with strabismus.

Anterior and posterior segments examination done with slit lamp

biomicroscope and a dilated fundoscopy using the binocular indirect ophthalmoscope were performed for the participants with strabismus and other ocular pathology in the KAAF eye centre.^[1]

Data collection: The data were collected with a semi-structured self-administered questionnaire.

Data analysis: Data was collated and presented using descriptive statistics as tables of frequencies, proportions, means, and standard deviations. Relevant comparative analyses were done for discrete variables with the Chi-square test, with the level of significance[p] set at < 0.05 . Data analyses utilised statistical packages for the social sciences (IBM SPSS 26).

Results

Sociodemographic characteristics of study participants

A total of two thousand seven hundred and fifty (2750) in-school adolescents took part in the study, and the participants from public schools were 1629 (59.2%). There were 1178 males with a male-to-female ratio of 1:1.3, the age range was 10-19 years, with a mean age of 13.57 ± 2.22 years. Participants in early adolescence were 1324 (48.1%), and the JSS1 class formed the largest population of 591 (21.5%), as shown in Table I.

Most mothers gave birth to the participants when they were between 15-29 years of age (61.1%), and mothers who had a tertiary education were 1175 (42.7%). Classification of mothers' occupation showed 54.5% of

Prevalence and Patterns of Strabismus

mothers were traders; the majority of the families had one to five children (82.8%). (Table II)

Table I: Socio-demographic characteristics of study participants (in-school adolescents)

<i>Variables</i>	<i>Frequency</i>	<i>Proportion</i>
Category of schools		
Public (Government)	1629	59.2
Private	1121	40.8
Gender		
Male	1178	42.8
Female	1572	57.2
Age range of participants (years)		
10-13 (early adolescence)	1324	48.1
14-16 (middle adolescence)	1151	41.9
17-19 (late adolescence)	275	10
Mean age $\pm$ SD	13.57 $\pm$ 2.22	
Academic class of participants		
JSS 1	591	21.5
JSS 2	531	19.3
JSS 3	342	12.4
SSS 1	553	20.1
SSS 2	403	14.6
SSS 3	331	12

Prevalence of strabismus

Twelve in-school adolescents were found to have strabismus, giving a prevalence of 0.44%, of which seven (58.3) were in public schools, and seven (58.3%) were females ($p = 0.949$), which was not statistically

significant. Eight (66.7%) participants with strabismus were between the ages of 14 and 16 years ($p\text{-value} = 0.626$), as shown in Table III. One hundred and sixty-six (6.04%) participants' parents gave a positive history that their children had strabismus, but only 5 (3.01%) among these children were confirmed to have strabismus (Figure

1). Twelve (0.44%) participants had examination.
strabismus confirmed on ocular

Table II: Socio-demographic characteristics of participants' mothers

Variable	Frequency	Percentage
Maternal age range at birth of participants (years)		
15-29	1681	61.1
30-44	1006	36.6
45-59	63	2.3
Mean age $\pm$ SD	28.86 $\pm$ 6.23	
Maternal education		
No formal education	134	4.9
Primary school	311	11.3
Secondary school	1130	41.1
Tertiary education	1175	42.7
Maternal occupation		
Housewife/unemployed	75	2.7
Unskilled/trader	1499	54.5
Semi-skilled/artisan	604	22
Professional/skilled	572	20.8
Number of children in the family		
1 – 5	2277	82.8
6 – 10	416	15.1
11 – 15	37	1.4
16 – 20	20	0.7

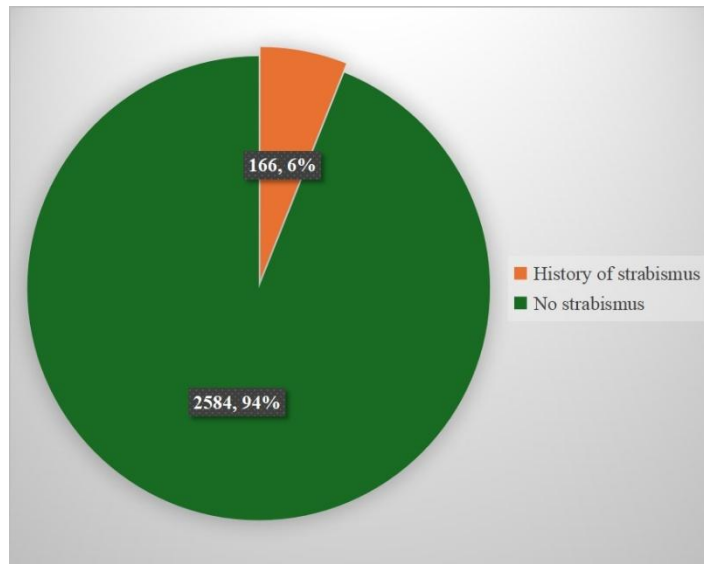


Figure 1: Self-reported prevalence of Strabismus

Table III: Comparison of the prevalence of strabismus with demographic characteristics

Variables	Strabismus (%)	No Strabismus (%)	P-value
All participants	12(0.44)	2738(99.6)	
School			
Public	7(58.3)	1622(59.2)	0.949
Private	5(41.7)	1116(40.8)	
Age (years)			
10-13	3(25)	913(33.3)	0.626
14-16	8(66.7)	1722(62.9)	
17-19	1(8.3)	103(3.8)	
Gender			
Male	5(41.7)	1174(42.9)	0.933
Female	7(58.3)	1569(57.1)	
Class			
JSS 1	2(16.7)	588(21.5)	0.094
JSS 2	0(0)	531(19.4)	
JSS 3	3(25)	339(12.4)	
SSS 1	1(8.3)	552(20.2)	
SSS 2	2(16.7)	401(14.6)	
SSS 3	4(33.3)	327(11.9)	

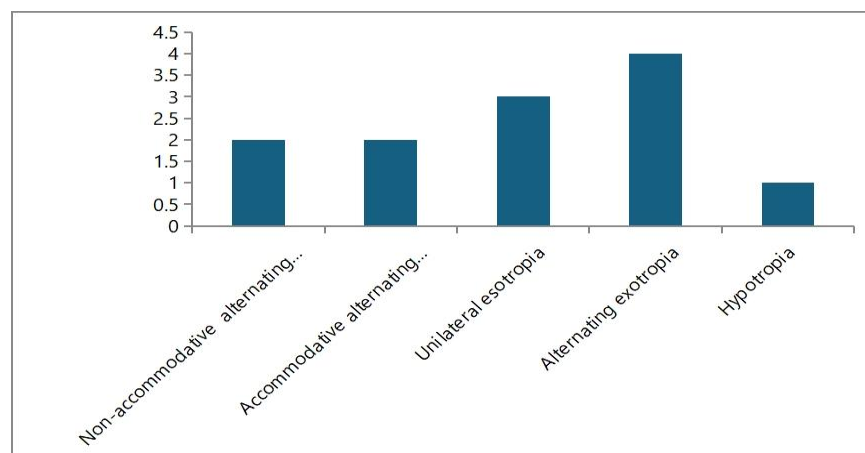


Figure 2: Patterns/type of Strabismus

Patterns of strabismus

Alternating strabismus was found in eight out of twelve (66.7%) participants with confirmed strabismus, of which four (33.3%) each were alternating exotropia and alternating esotropia, and two (16.7%) were accommodative esotropia (esotropia 50% and exotropia 33.3%). (Figure 2)

Participants with alternating esotropia and alternating exotropia had a positive history of spectacle wear, as did their family members (Tables IV and V)

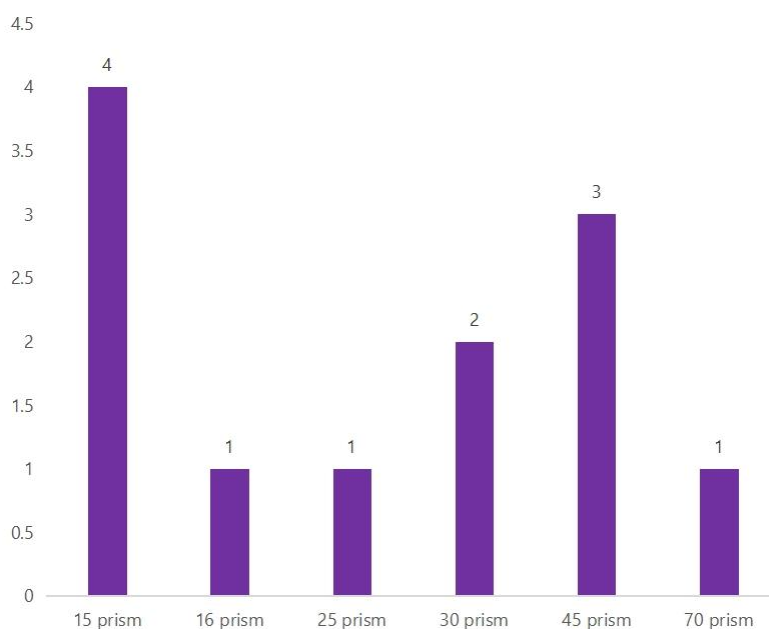


Figure 3: Angle of Strabismus

The angle of strabismus ranged between 15 and 70 prism diopters. There were two

peaks: ≤ 15 prism diopters (33.3%) and 45 prism diopters (25%). (Figure 3)

Table IV: Factors associated with clinical diagnosis of strabismus

Variables	Clinical diagnosis of strabismus		
	Yes (%) 12	No (%) 2738	χ^2 P value
Double vision			
No	9(75.0)	2372(86.6)	1.392
Yes	3(25.0)	366(13.4)	0.298
Poor vision			
No	6(50.0)	2125(77.6)	5.222
Yes	6(50.0)	613(22.4)	0.022
Restrict eye movement/unable to move eye as I want			
No	11(91.7)	2449(89.4)	0.063
Yes	1(8.3)	289(10.6)	0.803
History of trauma			
No	10(83.3)	2570(93.9)	2.285
Yes	2(16.7)	168(6.1)	0.131
Pregnancy for this child up to nine months			
No	0(0.0)	745(27.2)	4.478
Yes	12(100.0)	1993(72.8)	0.034
Child born prematurely/receive neonatal care/had yellowness of eyes			
No	11(91.7)	2528(92.3)	0.007
Yes	1(8.3)	210(7.7)	0.931
Mother received treatment for hypertension/diabetes/others			
No	12(100.0)	2632(96.1)	0.483
Yes	0(0.0)	106(3.9)	0.487
Any member of the family wears glasses			
No	7(58.3)	1573(57.5)	0.004
Yes	5(41.7)	1165(42.5)	0.951
Ever worn glasses before			
No	5(41.7)	2398(87.6)	22.845
Yes	7(58.3)	340(12.4)	0.000

Discussion

The prevalence of strabismus in this study is low (0.44%). The prevalence is the same value recorded in a cross-sectional study

conducted among school pupils aged 2-16 years at Ilorin,^[7] as well as the hospital-based component of a study in Ibadan, which reported a prevalence of 0.4%.^[17] It

is higher than the prevalence (0.3%) reported in a school-based study by researchers in Ilesha among participants aged 4-24 years.^[8] The observed differences may be due to population characteristics, particularly the age range of study participants, since this study was restricted to adolescents. A study among primary school pupils (aged 5-19 years) in Benin City reported a higher prevalence (0.89%) of strabismus compared to this study,^[6] while another study among secondary school students in Benin reported a prevalence of 2.4%.^[16] A similar study conducted among secondary school students in Ogun State reported a higher prevalence (1.9%) from 3 (senatorial districts) where 270 students were examined for strabismus, in contrast to findings from this study.^[18] The potential causes of differences in prevalence may include sociocultural (small sample size, wider age range), environmental and healthcare access factors, as well as possible underdiagnosis. Hospital-based studies conducted in Lagos (9.1% children below 16 years),^[19] Port-Harcourt, River State (0.6% among ages 0-35 years), and Benin, Edo State (5 months-14 years, 2.6%) reported significantly higher prevalence rates of strabismus compared to this study.^[6] Reports from a meta-analysis study asserted that higher prevalence rates were often found in hospital-based studies^[3] because it is patients with a particular disease condition who will present in the hospital.

This study found that 58.3% of participants who had strabismus were females, although

this was not statistically significant; this is similar to the findings reported in Benin (58%)^[6] and Port Harcourt (68.9%).^[20] It is, however, in contrast to the findings in Ilorin where males constituted 59.4% and females were 40.6%^[7]. This confirms that there is no sex predilection to the development of strabismus.

The fact that 166 (6.04%) parents gave a positive history that their children had strabismus and only 5 (3.01%) were confirmed to have strabismus, whereas seven (4.2%) participants gave a negative history of strabismus, who on examination were discovered to have strabismus, testified to the poor ability to identify strabismus correctly among the populace. Bodunde et al^[21] in a cross-sectional study had previously reported a low level of awareness and identification of strabismus among secondary school students in Sagamu. This study has buttressed this report and asserts that there might not have been a purposeful medical education to address this situation in the locality. In concordance with the findings from a qualitative study among parents in Sagamu, many participants in this study wrongly assumed their children had strabismus.^[21] The higher level of maternal education in this study was not associated with good knowledge of strabismus which is in contrast to the findings of Isawunmi et al^[22] in Osun state, Nigeria, who reported that people who had no formal education were 1.25% less likely to be aware of strabismus.

Table V: Factors associated with self-reported strabismus among adolescents

Variables	No (%) 2584	Yes (%) 166	χ^2 P value
Double vision			
No	2289(88.6)	92(55.4)	147.684
Yes	295(11.4)	74(44.6)	0.000*
Poor vision			
No	2062(79.8)	69(41.6)	130.715
Yes	522(20.2)	97(58.4)	0.000*
Restrict eye movement/unable to move eye as I want			
No	2348(90.0)	112(67.5)	90.515
Yes	236(9.1)	54(32.5)	0.000*
History of trauma			
No	2438(94.3)	142(85.5)	20.864
Yes	146(5.7)	24(14.7)	0.000*
Term pregnancy			
No	706(27.3)	39(23.5)	1.157
Yes	1878(72.7)	127(76.5)	0.282
Prematurity/neonatal admission/jaundice			
No	2402(93.0)	137(82.5)	23.937
Yes	182(7.0)	29(17.5)	0.000*
Medical conditions in pregnancy			
No	2492(96.4)	152(91.6)	9.996
Yes	92(3.6)	14(8.4)	0.002*
Any member of the family wears glasses			
No	1505(58.2)	75(45.2)	10.888
Yes	1079(41.8)	91(54.8)	0.001*
Ever worn glasses before			
No	2286(88.5)	117(70.5)	45.761
Yes	298(11.5)	49(29.5)	0.000*

The most common type of strabismus found in this study was esotropia accounting for 58.3%, mainly alternating esotropia (33.3%), similar to the findings in Ilorin (31.25%),^[7] Benin (62.9%),^[6] Port Harcourt (31.1%),^[20] Ghana,^[23] white Americans (3.9%)³ and among Australians, Robaei et al.^[24] Our finding of esotropia (58.3%) contrasts with findings of studies in Ilesha,

Nigeria (70%)^[8] and Singapore, Asia (72%)^[25], which reported exotropia as the most common. Esotropia was the most common type found in this study (58.3%), similar to the finding by Awoyesuku et al^[20] in a hospital-based study in Port Harcourt, who found alternating squint as predominant (37.9%).

This study showed that refractive error was associated with strabismus; about 7(58.3%)

participants with strabismus had a positive history of spectacle wear, similar to findings by Awoyesuku et al^[20] that hypermetropia was associated with esotropia as well as a hospital-based study in Benin.^[6] The participants with alternating exotropia found in this study were not myopic, although myopia has been reported to be associated with exotropia in some studies.^[3] Such reports may explain the high rate of exotropia in regions that have a higher prevalence of myopia in Asians. The angle of strabismus found was small, the majority were ≤ 45 PD (92%). Age and gender had no significant relationship with strabismus in this study, similar to the findings by Abdiyeva et al.^[26]

Limitations: This study was conducted among in-school adolescents within Sagamu township, which is in one of the twenty LGAs in Ogun State, and the findings of the study may not adequately depict the prevalence of strabismus in Ogun State. Mothers of the participants' knowledge about strabismus is poor, and they are liable to recall bias.

Conclusion

This study found that the prevalence of strabismus was low, 0.44%, among in-school adolescents in Sagamu. Esotropia is the most common type of strabismus among them, including the most common angle of strabismus of ≤ 45 PD. Strabismus is associated with refractive error but not associated with socio-demographic factors among the in-school adolescents.

The following recommendations are proposed: there is a need for eye examination after birth, and pre-school eye screening may help to identify children with strabismus early. Integration of vision screening into school health programs, training of school teachers and school health personnel, and advocacy for broader vision surveys within the other LGAs to make it representative of the prevalence of strabismus in the entire Ogun State.

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Authors' Contributions: OAS conception and design of research, OAS, BOT, AHA, OOO data analysis and interpretation OAS, BOT drafting of manuscript OAS, BOT, AHA, OOO revision of drafts OAS, BOT, AHA, OOO approval of the final version.

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