International Journal of Health Sciences and Research
DOI: https://doi.org/10.52403/ijhsr.20210732
Vol.11; Issue: 7; July 2021
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

The Presentations of Convergence Insufficiency among Young Adults (18-25 Years)

Jacqueline E. Obioma-Elemba*, Nnenne U. Onu†, Okechi U. Amaechi†, Peace C. Anyaoha*

*Department of Optometry, Imo State University, Owerri, Imo State, Nigeria
†Department of Optometry, Abia State University, Uturu, Abia State, Nigeria

Corresponding Author: Jacqueline E. Obioma-Elemba

ABSTRACT

Convergence Insufficiency is a major binocular vision dysfunction commonly found among the youth. The prevalence of convergence insufficiency has been studied extensively; however there are limited data available on the prevalence of the various presentations of convergence insufficiency among young adults.

Convergence insufficiency is associated with symptoms such as fatigue, blurred vision at near, intermittent diplopia at near, "eye strain," tension in and around the eyes, and the sensation of the print moving while reading. However, convergence insufficiency may present with or without symptoms. The exact prevalence of convergence insufficiency is not known.

This study assessed the various presentations of convergence insufficiency among the young adults (aged 18 – 25 years) within the Imo State University community, Owerri, Nigeria, using a cross-sectional study design. Through purposive sampling, a sample size of 162 participants was used for this study after screening and pre-assessment. The Convergence Insufficiency Symptom Survey (CISS), the near point of convergence test, the Von Graefe phoria tests (at far and at near) and the positive fusional vergence tests were administered to all of the study participants.

Convergence insufficiency among the young adults of Imo State University presented with symptoms (without clinical signs, 14.2%; with clinical signs, 16.6%) and without symptoms convergence insufficiency (27.8%). The study revealed that convergence insufficiency with symptoms was the more prevalent presentation of convergence insufficiency within the study population.

A high percentage of young adults within the study population tested positive for convergence insufficiency, presenting with symptoms (with or without clinical signs) or without symptoms.

Key Words: Binocular vision, convergence insufficiency, young adult, symptoms, diplopia, phoria.

INTRODUCTION

Convergence insufficiency (CI) is a binocular vision dysfunction characterised by the inability of a subject to accurately converge or sustain accurate convergence in order to maintain fixation at near.[1] It is associated with symptoms such as diplopia, eye strain, blurred vision, headaches, eye fatigue and general fatigue.[2]

Convergence insufficiency (CI) is the most common cause of ocular discomfort and is more common among children and young adults within the age group of 15 to 25 years than other age groups.[3] The exact prevalence of CI in the general population is unknown due to the absence of population-based epidemiological studies. [4] Reports on CI prevalence are available mostly from school-based studies (especially among Caucasian populations), as most studies have been focused on young school children. However, though largely difficult to ascertain, reports of the prevalence of CI

in specific clinical population varies widely and ranges between 1.75% and 33%. [2, 3, 5 - 7]

Based on the underlying cause, CI may be either primary or secondary to an underlying aetiology such as refractive errors or strabismus or drug use. [3] First time use of presbyopic correction lenses is also associated with the development of CI. [3] Extra ocular muscle imbalance in the form of exophoria, intermittent exotropia and vertical muscle imbalance, if left untreated for long time, may be associated with CI. Drugs which reportedly decrease accommodation can also induce CI. [8]

Convergence insufficiency may present with symptoms or without the symptoms associated with CI. [9] CI without symptoms may be further classified as low suspect, high suspect or definite CI as recommended by the Convergence Insufficiency and Reading Study group. [2]

Purpose of study

Although some studies have reported on the frequency of symptomatic CI, few have provided data about the frequency of asymptomatic CI. The prevalence of CI has largely been difficult to ascertain [2, 4, 10] and varies widely across the globe. [6] There is also a paucity of information on the percentage of CI sufferers who are symptomatic in relation to those who are asymptomatic in their presentation. This study was designed to fill a gap in the literature, by providing population-based data about the frequency of CI in young adults and information about the percentage of CI presenting with symptoms versus CI presenting without symptoms in this population.

Aim and objectives of study

This study was aimed at assessing the various presentations of convergence insufficiency (CI) among young adults within the Imo State University community.

The objectives include:

i. To assess young adults within the 18 – 25 year age range for CI symptoms by administering the Convergence Insufficiency Symptom Survey (CISS).
ii. To assess young adults for CI by administering near point of convergence test (NPC), Positive fusional vergence test and Von Graefe phoria test
iii. To determine the various presentations of convergence insufficiency among young adults.

Significance of study

The outcome of this study, while contributing to existing body of knowledge on the prevalence of CI, exposes the various presentations of convergence insufficiency revealing their prevalence among the study population. Such information is beneficial to clinicians in their efforts to provide better care for young adults with CI while highlighting the importance of binocular vision assessment in young adults who are exposed to increased near visual demands.

MATERALS AND METHODS

This study was conducted in Owerri, the host city for the Imo State University, and the capital city of Imo State, Nigeria, at the Imo State University Optometry Clinic.

The study was approved by the Research and Ethics committee of the department of Optometry, Imo State University; all the procedures used in this study were done in accordance to the principles of the Helsinki Declaration. Only participants who voluntarily gave their written informed consent to participate were enrolled in this study.

All intending participants were pre-screened to determine their eligibility for participation in this study by administering a short questionnaire to document their demographic characteristics, eye health history, and medical history. In addition to this, preliminary eye exams were also conducted – binocularity assessment (cover/uncover test), refractive status assessment (retinoscopy and subjective refraction), and assessment of the accommodative system (near point of

accommodation and amplitude of accommodation).

Prospective participants with developmental disorders like attention deficit hyperactivity disorder, dyslexia, literacy disorders [11, 12] or other health conditions that could interfere with validity of the binocular vision assessments such as Graves, Parkinson's or Myasthenia Gravis disease [2] were excluded from participation. Intending participants were within the stipulated age limit, with functional binocular vision and adequate accommodative abilities present [13, 14, 15], not currently suffering malaria or using any (anti-malarial) drugs and without history of ocular/ head trauma.

The sample size of 162, derived using the Yamane [16] formula with a 95% confidence interval, was drawn from healthy young adults aged 18- 25 years who met the inclusion criteria.

The symptoms of CI were assessed using the convergence insufficiency symptom survey (CISS), a questionnaire of 15 questions designed to qualify the severity of symptoms associated with convergence insufficiency [13] as well as quantify the magnitude, the frequency and severity of the symptoms reported by individuals with symptomatic CI. [17] The CISS as a self-report symptom inventory has been shown to have good construct validity and reliability. [13] The 15 symptom questions were administered to all the eligible participants for the study, as the research instrument to assess the presence or absence of CI symptoms. The 15 responses were summed to obtain the total CISS score ranging from 0 (least symptomatic) to 60 (most symptomatic) for each participant. A CISS score of ≥16 for participants 18 years old and ≥21 for participants aged 19 – 25 years was considered symptomatic. [9, 18]

The clinical signs and diagnostic system for the diagnosis of CI as recommended by the Convergence Insufficiency and Reading Study group [2] include exophoria at near, exophoria at near that is ≥ 4^{Δ} greater in magnitude than the distance phoria, insufficient positive fusional vergence (fails Sheard's criteria or poor positive fusional vergence at near ≤ 12^{Δ} base-out blur or ≤ 15^{Δ} base-out break) and receded near point of convergence of ≥ 7.5 cm break or ≥ 10.5 cm recovery.

The near point of convergence test was administered to all the participants for this study with the Royal Air Force near point rule and the point tip of a pen using the push-up-to-break technic. With the participant comfortably seated in room with ambient lighting and examiner on same eye level as the participant, the tip of a pen was presented to the participant at his body midline at about 50cm away from his face, placed next to the positioned rule. The participant was then instructed to focus on the pen tip, try to maintain clear single vision while tracking it with his eyes and report immediately he noticed a blur of the point tip target or experienced double vision of the target. The examiner then slowly moved the pen (tip) toward the nose of the participant along the near point rule while observing his eye until the participant reported double vision or a slight divergent movement was noticed by the examiner in one of the eyes of the participant. From the near point rule, the distance from the nose bridge (just below the eye brow) to the tip of the pen at the point of diplopia was measured to the nearest centimetre and recorded as the break near point of convergence. [19] The target (pen tip) was then slowly moved backward along the same line from the face of the participant till he reported that a single image was restored or his eyes had regained triangulation on the target, this point was also measured from the nose bridge plane and recorded as the near point of convergence recovery point. [19] At least three readings were taken per participant. For this study, readings above 7.5cm for break values and 10.5cm for recovery values were classified as CI suspects. [2]

Horizontal phoria for all the eligible participants was assessed at far (6m) and at near (40cm) using the Von Graefe method

on a phoropter with their refractive corrections in place and the examination room well-illuminated. While the participant focused at the best visual acuity line on the visual acuity chart (at prescribed test distances at 6m and 40cm), the dissociating prism (6^{Δ} base up) was positioned before the left eye and a measuring prism (15^{Δ} base in) before the right eye using rotary prisms. When diplopia was confirmed, the participant was asked to report once the two images aligned vertically and then the examiner slowly reduced the 15^{Δ} base in till the participant reported vertical alignment of the test target. The residual prism value was recorded as the phoria status of the participant at the specified test distance - with base in for exophoria, base out for esophoria, 0 for orthophoria. [15] Exophoria at near greater than at distance by at least 4^{Δ}diopters is generally a clinical indication of CI and was recorded as so for this study. [2]

The positive fusional vergence test was performed with participant comfortably seated at the phoropter and focusing at a particular character on his best visual acuity line (through his refractive correction, if any), and the Risley prisms set at zero, the examiner then slowly increased the prism power in base-out direction, in both eyes simultaneously. At the point when a sustained blur of the test target was reported, the sum of the prisms was recorded as the blur point; when the target doubled, the sum of the prisms was recorded as the break point. The examiner then slowly reduced the prisms toward the base in direction, in both eyes simultaneously, till the participant reported a single target, the sum of the prisms were then recorded as the recovery value for the test. With the eyes of the participant closed, the examiner then slowly returned the prisms to zero. [15] For this study, recovery values of less than 15^{Δ} were considered indicative of CI. [2]

The various test results were categorised based on the various presentations of CI:

(a) CI with symptoms and no signs: all results that tested positive for CISS and negative for the clinical diagnostic tests.

(b) CI with symptoms and signs: all results that tested positive for CISS as well as positive to any clinical diagnostic tests.

(c) CI with no symptoms: all the results presenting positively for the clinical signs of CI[1] and negative for CISS. These were further sub-grouped as one-sign, two-sign and three-sign CI presentations. [2]

(d) No CI: all findings testing negative to both CISS and clinical diagnostic CI signs (No CI symptoms and signs).

Statistical Analysis

The data collated were statistically analysed using descriptive analysis, t-tests and analysis of variance to determine the various presentations of CI among the study as well as frequencies of symptomatic CI versus asymptomatic CI within the study population.

RESULTS

The study results showed a high prevalence of CI among the young adults aged 18 – 25years, with 58.6% of the study population (95) testing positive to CI in at least one of the four tests carried out in this study and 41.4% (67) testing negative to all of the four CI tests (Table 1).

Table 1: Prevalence of Convergence Insufficiency

Category	Frequency (N)	Percentage (%)
Convergence insufficiency (CI)		
Positive CI	95	58.6
Negative CI	67	41.4
CI presentation		
CI with symptoms	50	30.9
CI with Symptoms (no sign)	23	14.2
CI with Symptoms (with sign)	27	16.6
CI without symptoms	45	27.8

The CI-positive participants presented without symptoms (27.8%) and with symptoms (with clinical signs, 14.2% and without clinical signs, 16.6%); CI presentation with symptoms was more common of the two presentations (Figure 1).

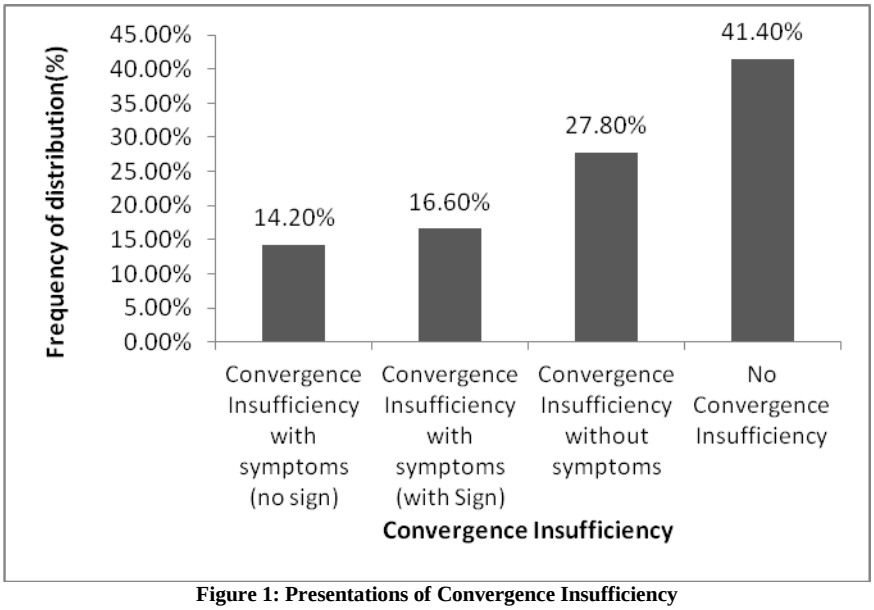

Figure 1: Presentations of Convergence Insufficiency

From the groups statistics (Table 2), Scheffe Post Hoc analysis revealed that the symptomatic CI and asymptomatic CI varied significantly over the symptom survey, the near point of convergence and the phoria tests, with these tests statistically differentiating them (analysis of variance with Post Hoc tests > Scheffe Post Hoc analysis).

Table 2: Mean test scores of the presentations of CI

CI presentation	N (162)	Mean of survey scores	Mean of Break/Recovery	Mean of Phoria difference	Mean of positive fusional vergence
CI with symptom (with no sign)	21	25.4	6.7/9.8	2.1	19.6
CI with symptom (with sign)	29	24.6	8.2/11.3	3.0	16.5
CI without symptom	25	11.9	8.0/11.3	2.0	16.0
No CI	67	11.3	6.7/10.9	2.2	20.2

Convergence insufficiency presentation without symptoms within the study population consisted of 3 groups (Figure 2), CI without symptom with 1-sign (64.4%), 2-sign (32.1%) and 3-sign (4.4%). Based on the frequency of CI signs presented, CI without symptom but with only one sign was the most common presentation of the three; 2 participants (4.4% of the sub-group) presented with definite asymptomatic CI, exhibiting all three signs of CI upon assessment (Table 3).

Table 3: Mean test scores of asymptomatic CI presentations

CI without symptom presentation	N (45)	Mean of symptom Survey scores	Mean of Break/recovery	Mean of Phoria difference	Mean of Positive fusional vergence
1-sign	29	11.4	7.9/10.8	2.2	17.9
2-sign	14	12.1	8.0/10.9	4.1	12.6
3-sign	2	16.5	8.3/11.8	5.3	11.0

Outcomes from the analysis of variance (ANOVA) with confidence interval of 95%, significance level (α) – 0.05 and P>0.05 revealed that the mean scores of the presentations of asymptomatic CI (1-sign, 2-sign and 3-sign) varied in the phoria and positive fusional vergence tests. For CISS scores, with $F_{2,42}$=0.960, the p-value of 0.391 is greater than 0.05. Therefore, the null hypothesis is not rejected. The P-value for the ANOVA test indicates that groups CI without symptoms with 1 sign, 2 signs, and 3 signs, do not vary significantly in respect to their CISS scores. For the NPC break Scores**,** $F_{2,42}$=0.099, the p-value (0.906) is greater than 0.05, the null hypothesis is accepted. Convergence insufficiency without symptoms but with 1 sign, 2 signs, and 3 signs does not significantly vary across their NPC Break

Scores. For Von Graeffe Phoria results**,** with $F_{2,42}$=11.797, and the p-value (0.000) is less than 0.05, therefore the null hypothesis is rejected and CI without symptoms with 1 sign, 2 signs, and 3 signs significantly vary in the Von Graeffe Phoria tests. For positive fusional convergence with $F_{2,42}$=8.510, the p-value (0.001) is less than 0.05, therefore the null hypothesis is rejected and scores for CI without symptoms with 1 sign, 2 signs, and 3 signs significantly vary in the positive fusional convergence tests.

This suggests that the Von Graefe and positive fusional vergence tests can be used to classify CI without symptom based on number of signs, within a sample.

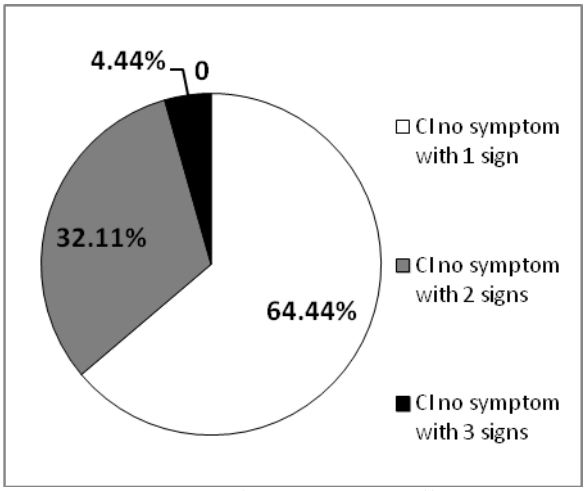

Figure 2: Presentations of Convergence Insufficiency without symptoms

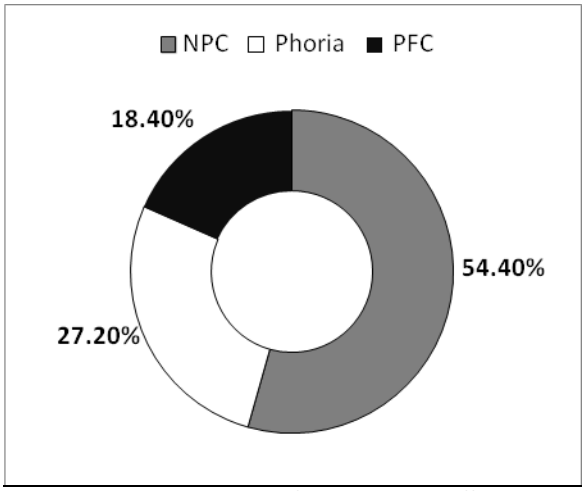

Figure 3: Diagnostic signs of convergence insufficiency

A receded near point of convergence of (≥ 7.5 cm break; ≥ 10.5 cm recovery) was the most common clinical sign presented by the participants assessed in this study (Figure 3).

DISCUSSION

The frequency of CI among the study sample was 58.6% - presenting with at least one sign of CI and/or positive for symptoms, upon assessment. The participants in this study were students of Imo State University; young adults who have high near task visual demands as students, and are avid users of digital hand-held/near devices for both academic and recreational/social uses. The incidence of CI reportedly increases with additional near work demand, as well as vocational/non vocational visual demands that require prolonged close work [7, 20]. These factors are likely to have contributed to the high frequency of CI among the study population.

In this study, 27.8% of the study population tested positive to CI without presenting any symptoms. The higher frequencies of CI presentations without symptoms could be because majority of the study population still have good compensation for their relative divergent binocular alignment, thus experiencing no obvious symptoms of CI [7]; it may also be due to their high tolerance to discomfort. The most frequent feature of CI without symptoms presented in this study was receded near point of convergence of more than 7.5cm for break and more than 10.5cm for recovery, with 34.6% of the study population recording a receded near point of convergence.

Based on the frequency of clinical signs presented in this study, 29% of the study population (47) presented with only 1 clinical sign, 11.7% (19) presented with 2 signs and 3.7% (6) presented with all three clinical signs of CI. About 15.4% of the young adults in this study presented with clinically significant CI (positive for 2 or 3 signs). In the studies by Rouse *et al.,* [21] among 9 – 13 year olds, 4.2% of 453 school children (19) presented with all 3 signs of CI and 8.8% had 2 signs of CI, recording a

prevalence of clinically significant CI among school children as an estimated 13%. The studies by Hassan *et al.*, [6] assessing secondary school students (aged 13 – 18 years) in Sudan reported a CI prevalence of 7.5%, based on assessments of only clinical signs.

Studies on a clinic population were conducted by Rouse *et al.*, [13] where the authors studied the frequency, distribution and characteristics of CI in a sample of 8 to 12-year-old school children. The authors reported that 33% of the participants had low suspect CI, 12% had high suspect and 6% had definite CI. About 17.6% had CI with 2 or more signs (classified as clinically significant CI). These studies were focused on school aged children.

CI with symptoms was also revealed as a CI presentation among the study population; 14.2% of the study population tested positive for symptomatic CI, and negative for clinical signs of CI while 16.6% tested positive for both symptomatic CI and the clinical signs. In a study by Horwood *et al.*,[11] 15% of the 167 university undergraduates within the age range of 18 – 26 years in a UK college qualified as symptomatic CI sufferers. On the other hand, the school-based study by Darko Tarkyi *et al.* [22] in Ghana among younger populations revealed that 8.6% of the 220 students (aged 12 - 17years) had symptomatic convergence insufficiency.

The results of this study show that many of the young adults within the Imo State University community tested positive to CI. Based on these findings and given the high prevalence of CI presentations among the young adults revealed by this study, optometry clinicians must suspect and routinely screen for both symptomatic and asymptomatic CI among young adults.

CONCLUSION

All CI patients exhibit varying clinical signs and/or symptoms that distinguish them as asymptomatic or symptomatic (with or without clinical signs). These various presentations of CI were revealed among the young adults within the Imo state University, Owerri community, with symptomatic CI as the most common form of CI presentation.

ACKNOWLEDGEMENTS

We are grateful to the management of Imo State University Optometry Clinic.

The authors have no conflict of interest to declare in this study.

Conflict of Interest: None

Source of Funding: None

Ethical Approval: Approved

REFERENCES

1. Davis AL, Harvey EM, Twelker JD et al. Convergence insufficiency, accommodative insufficiency, visual symptoms and astigmatism in Tohono O'odhan students. J Ophthalmol [serial on the internet].2016 July [cited August 2019]; 2016 [7 p] Available from: http://dxodoi.org/10.1155/2016/6963976
2. Rouse MW, Hyman L., Hussein M et al. Frequency of convergence insufficiency in optometry clinic settings. Convergence Insufficiency and Reading Study (CIRS) group. Optom Vis Sci 1998; 75: 88 – 96.
3. Agrawal M, Sharma M, Garesh S. Convergence insufficiency. Med Ophthalmol DOS Times 2006; 2: 465 – 467.
4. Cacho-Martínez P, García-Muñoz Á, Ruiz-Cantero MT. Do we really know the prevalence of accomodative and nonstrabismic binocular dysfunctions? J Optom 2010; 3:185 – 197.
5. Borsting EJ, Mitchell GL. Kulp MT et al. Improvement in academic behaviours after successful treatment of convergence insufficiency. Optom Vis Sci 2012; 89: 12 – 18.
6. Hassan LI, Ibrahim SM, Abdu M et al. Prevalence of convergence insufficiency among secondary school students in Khartoum, Sudan. Oman J Ophthalmol 2018; 11: 129 – 133.
7. Wajuihian SO, Hansraj R. Review of non-strabismic accommodative-vergence anomalies in school-age children. Part 1: Vergence Anomalies. Afr Vis Eye Hlth

[serial on the internet]. 2015 Aug [cited August 2019]; 32: [10 p]. Available from: http://dx.doi.org/10.4102/aveh.v74i1.32
8. Sathyan S, Beena NF, Nair D et al. Convergence insufficiency: A major review. Kerala J Ophthamol 2016; 28: 88 – 95.
9. Borsting EJ, Rouse MW, Mitchell GL. et al. Validity and reliability of the revised convergence insufficiency symptom survey in children aged 9 to 18 years. Optom Vis Sci 2003; 80: 832 – 838.
10. Ovenseri-Ogbomo GO, Eguegu OP. Vergence findings and horizontal vergence dysfunctions among first year university students in Benin City, Nigeria. J Optom 2016; 9: 258 – 263.
11. Horwood AM, Toor S, Riddell PM. Screening for convergence insufficiency using the CISS is not indicated in young adults. Br J Ophthalmol 2014; 98: 679 – 683.
12. Granet DB, Gomi CF, Ventura R et al. The relationship between convergence insufficiency and ADHD. Strabismus 2005; 13: 163 – 168.
13. Rouse M, Borsting E, Mitchell GL, et al. Validity of the convergence insufficiency symptom survey: A confirmatory study. Optom Vis Sci 2009; 86: 357- 363.
14. Marran LF, De Land PN, Nguyen AL. Accommodative insufficiency is the primary source of symptoms in children diagnosed with convergence insufficiency. Optom Vis Sci 2006; 83: 281 – 289.
15. Elliot D. Clinical Procedures in Primary Eye Care, 4th ed. China: Elsevier Limited, 2014.
16. Yamane T. Statistics: an introductory analysis. 2nd ed. New York: Harper & Row, 1973.
17. Barnhardt C, Cotter SA, Mitchell GL et al. (2012). Symptoms in children with convergence insufficiency: before and after treatment. Optom Vis Sci 2012; 89: 1512 – 1520.
18. Rouse MW, Borsting EJ, Mitchell GL et al. Validity and reliability of the revised convergence insufficiency symptom survey in adults. Ophthalmic Physiol Opt 2004; 24: 384 – 390.
19. Maples WC, Hoenes R. Near point of convergence norms measured in elementary school children. Optom Vis Sci 2007; 84: 224 – 228.
20. Von Noorden GK, Campos EC. Binocular vision and ocular motility: Theory and Management of Strabismus. 6th ed. St. Louis: Mosby; 2002. pp. 502–3.
21. Rouse MW, Borsting E, Hyman L et al. Frequency of convergence insufficiency in fifth and sixth graders. The Convergence Insufficiency and Reading Study group. Optom Vis Sci 1999; 76: 643 – 649.
22. Darko-Tarkyi C, Khan NE, Nirghin U. Symptomatic vergence disorders in junior high school children in Ghana. Afr Vis Eye Hlth [serial on the internet]. 2016 July [cited August 2019]; 333: [8 p]. Available from: http://dx.doi.org/10.4102/aveh.v75i1.333

How to cite this article: Jacqueline E. Obioma-Elemba, Onu NU, Amaechi OU et.al. The presentations of convergence insufficiency among young adults (18-25 years). *Int J Health Sci Res.* 2021; 11(7): 235-242. DOI: *https://doi.org/10.52403/ijhsr.20210732*

******