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THE RELATIONSHIP BETWEEN BINOCULAR VISION DISORDERS AND ACADEMIC PERFORMANCE AMONG STUDENTS OF FEDERAL POLYTECHNIC NEKEDE, OWERRI

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ABSTRACT

Binocular Vision Disorder (BVD) may interfere with reading, concentration, visual comfort and other activities requiring sustained near vision and may consequently be associated with academic performance. This study investigated the relationship between non strabismic BVDs and academic performance among students of Federal Polytechnic Nekede, Owerri. A descriptive analytical cross-sectional study design was adopted. A total of 440 students were selected using a multistage sampling technique. Participants underwent binocular vision assessment, including visual acuity measurement, cover test, near point of convergence, accommodation, and the Titmus Stereo Fly tests. Academic performance was assessed using the students' most recent semester cumulative grade point average (CGPA), which was categorized for the purpose of analysis. Data were analyzed using the SPSS version 23. Descriptive statistics were presented using frequencies and percentages, while the chi-square test was used to determine the association between BVDs and academic performance at a 5% level of significance. Of the 440 students examined, 132 (30.0%) had at least one BVD, while 308 (70.0%) had no identified BVD. Among students with BVDs, 83 (62.9%) had lower academic performance compared with 67 (21.8%) among those without BVDs. Chi-square analysis revealed a statistically significant association between BVDs and academic performance ($\chi^2 = 69.55$, df = 1, $p < 0.001$). The study found a statistically significant association between binocular vision disorders and academic performance among the students studied. It is recommended that routine binocular vision assessment be incorporated into tertiary institution health programs, particularly for students who report visual difficulties during academic activities.

Keywords: Binocular Vision Disorders; Academic Performance; Students; Binocular Vision; CGPA; Federal Polytechnic Nekede.

1 INTRODUCTION

Binocular vision is a critical visual process that allows for the integration and coordination of visual stimuli from both eyes into a single, unified image (Ezinne et al., 2025). This process is essential for depth perception and provides a broad field of view, contributing to a range of everyday activities, from reading to navigating complex environments. The brain's ability to fuse these inputs relies on the effective functioning of the vergence and accommodative systems, which are integral for maintaining proper eye alignment and focusing on objects at various distances. When these systems fail to function properly, it can lead to binocular vision anomalies, a category of dysfunctions that impair the coordination of the two eyes and disrupt optimal visual performance (Candy and Cormack, 2022). Binocular vision is a critical sense for learning, particularly in the classroom, where reading, writing, and other visual tasks are central. Xu et al (2025), in their study stated that visual impairment can have adverse effects on the physical and mental development, quality of life and learning outcomes of children and adolescents.

Binocular vision disorders (BVDs) occur when the two eyes do not work together efficiently. They are generally classified into strabismic (heterotropia) and non-strabismic types, which include phorias, accommodative, and vergence anomalies. Among these, the most commonly encountered binocular vision anomalies are accommodative dysfunctions, convergence insufficiency, and heterophoria (Sharma *et al.*, 2024; Shrestha and Kaiti, 2022). Accommodative dysfunction involves difficulty in adjusting focus between near and far distances. Accommodative insufficiency has been described as a binocular vision disorder involving deficient focusing ability during near work and may be associated with reduced visual comfort and work performance (Enaholo & Gurnani, 2026). It can result in symptoms such as blurred near vision, headache, ocular discomfort and difficulty maintaining focus while convergence insufficiency refers to an inability to align the eyes properly when focusing on near objects, leading to double vision or discomfort (Saikia *et al.*, 2024). Common symptoms of convergence insufficiency include eyestrain, headache, blurred vision, intermittent diplopia, difficulty concentrating, loss of place while reading, movement of print and reduced reading endurance (Gantz & Stiebel-Kalish, 2022). Heterophoria is a misalignment of the eyes that occurs when binocular vision is disrupted but can be compensated for under normal conditions (Benhaim-Sitbon *et al*., 2022). These anomalies can reduce visual efficiency to a great extent and diminish stereoacuity (the ability to perceive depth and three-dimensional structure). Accordingly, sustained near work requires continuous interaction between the accommodative and vergence systems (Cacho-Martínez et al., 2024; Ntodie et al., 2023).

Students rely extensively on their visual system for academic activities. Reading textbooks, writing, using computers, viewing projectors, taking examinations and studying for prolonged periods all require sustained visual attention, especially at near distances. A student may have relatively good visual acuity but still experience difficulty with near tasks because of an underlying binocular or accommodative problem. Symptoms may include eyestrain, headache, blurred vision, intermittent diplopia, difficulty concentrating, loss of place while reading and discomfort during prolonged near work. Ovenseri-Ogbomo and Eguegu (2016) found that blurred vision, headache and diplopia were among the most frequently reported symptoms among students diagnosed with vergence dysfunctions. A research among young adults found that prolonged computer use was associated with accommodation and convergence problems and greater computer-related visual symptoms (Wicaksana and Sirait, 2024). Similarly, a study among school-aged children found that those who used digital devices for longer periods had significantly reduced accommodative amplitude, accommodative facility and positive fusional vergence compared with lower-use groups (Maharjan et al., 2022).

Academic performance refers to the extent to which a student achieves the expected educational outcomes, usually reflected through measures such as examination scores, grades, grade point average (GPA), or cumulative grade point average (CGPA). Binocular vision disorders may be significant to academic performance because many educational activities require sustained and effective use of accommodation, convergence, fusion, and stereopsis. Therefore, assessment of accommodation, near point of convergence, near phoria, positive fusional vergence and binocular accommodative facility can be important when evaluating students who report eyestrain or difficulty with prolonged reading and other near tasks. For instance, the study by Gawde et al. (2026), supports the relationship between binocular vision dysfunction and performance on near-work tasks. Their study revealed that college students with convergence insufficiency had significantly slower reading, writing, and typing speeds than students without convergence insufficiency. Federal Polytechnic Nekede, Owerri, has a large population of students engaged in academic activities involving prolonged reading and digital-device use. Investigating the relationship between binocular vision disorders and academic performance among these students may provide useful information for eye-care practitioners and educational administrators. This study therefore seeks to investigate whether non-strabismic binocular vision disorders (including Convergence insufficiency, Accommodative insufficiency, stereoacuity, near esophoria and fusional vergence) are associated with academic performance among students of Federal Polytechnic Nekede, Owerri.

Objectives of the study

General Objective

The aim of this study was to determine the relationship between non-strabismic binocular vision disorders and academic performance among students of Federal Polytechnic Nekede, Owerri.

Specific Objectives

- To determine the prevalence of binocular vision disorders (including Convergence insufficiency, Accommodative insufficiency, reduced stereoacuity, near esophoria and fusional vergence dysfunction) among students of Federal Polytechnic Nekede, Owerri.
- To determine the academic performance of students with binocular vision disorders in Federal Polytechnic Nekede, Owerri.
- To determine the academic performance of students without binocular vision disorders in Federal Polytechnic Nekede, Owerri.
- To determine whether there is a significant relationship between binocular vision disorders and academic performance among students of Federal Polytechnic Nekede.

2 MATERIALS AND METHODS

2.1 Study Design

An analytical cross-sectional study design was adopted.

2.2 Study Area

The study was carried out at Federal Polytechnic Nekede, located in Owerri west Local Government Area (LGA), within a six (6) month period. Federal Polytechnic Nekede is a federal government owned higher institution located in Nekede, a town in Imo state, South-Eastern Nigeria. The Institution offers ND (National Diploma) and HND (Higher National Diploma) course at undergraduate levels. It has eight (8) schools (faculties) of study; School of Engineering Technology (SET), School of Industrial and Applied Sciences (SIAS), School of Business Management Technology (SBMT), School of General Studies (SGS), School of Environmental Design and Technology (SBMT), School of Information and Communications Technology Owerri (SICT), School of Agriculture and Agricultural Technology (SAAT), School of Health and Related Technology (SORHT). The institution comprises students enrolled in various departments and programs.

2.3 Study Population

The study population consisted of students of ND (National Diploma) and HND (Higher National Diploma) in the various schools/faculties that make up the Federal Polytechnic Nekede, Owerri. According to the key institutional data, the total student population at Federal Polytechnic , Nekede is 28, 687 (FPNO portal, 2025)

2.4 Sample Size and Sampling Technique

A sample size of 440 was made use of. The sample size was calculated using the Taro Yamane formula for sample size calculation for a given population, formulated by the statistician Taro Yamane in 1967. The mathematical illustration of the Taro Yamene formula is as follows:

$n = N/1 + N (e)^2$

where, n is the sample size

N is the population under study and

e is the marginal error

Therefore, to determine the sample size for the study, n using the formula

$n = N/1 + N(e)^2$ and substituting the figures appropriately,

$n = 28, 687 \div (1+ 28, 687 (0.05)^2$

$n = 28, 687 \div [1 + 28,687 (0.0025)]$

= 28,687 ÷ [1 + 71.7175]

= 28, 687 ÷ 72.7175

= 395

The sample size was increased by 10% to compensate for non response

10% of 395 = 39.5 approx. 40

Therefore, 395+ 40 = 435. This was however, approximated to 440 to ensure effective representation of the entire student population. Sample size for the study was therefore 440

2.5 Sampling Technique

A multistage sampling technique was used.

2.5.1 Stage 1: Faculties/schools were identified

The Federal Polytechnic Nekede comprises eight schools. Based on the sampling guideline attributed to Mugenda and Mugenda as cited by Muya et al. (2024), which recognizes a range of approximately 10% to 30% of the target population as an acceptable sampling fraction in certain research situations, 30% was considered in determining the number of schools to be selected. 30% of the eight schools yielded 2.4 schools. Since a fraction of a school could not be selected, the figure was rounded up to three schools, representing 37.5% of the total schools. The three schools were selected using simple random sampling to give each school an equal opportunity of being included in the study. The selected schools were School of Engineering Technology (SET), School of Environmental Design and Technology (SEDT) and School of General Studies (SGS)

2.5.2 Stage 2: Departments were selected from the chosen Schools.

This stage involved listing all the departments in each of the selected schools.

In School of Engineering Technology (SET): There are ten departments which include Agricultural and Bioenvironmental Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Mechatronics Engineering, Material and Metallurgical Engineering, Mineral and Petroleum Resources Engineering, Welding and Fabrication Engineering Technology.

In School of Environmental Design and Technology (SEDT): There are seven departments which include Architecture, Art and design, Building Technology, Estate Management, Quantity Surveying, Surveying and Geoinformatics, Urban and Regional planning.

In School of General Studies (SGS): There are three departments which include Mass communication, Humanities and Social Sciences

The sample size of 440 was shared proportionally among the listed departments using the ratio of 10:7:3

Solving this mathematically, 10+7+3 = 20

$\frac{440}{20} = 22$

Therefore, using the ratio, 10:7:3

(22 x 10) + (22 x 7) + (22 x 3)

This resulted to; 220 + 154 + 66 = 440

That is 220 students from School of Engineering Technology, 154 students from School of Environmental Design and Technology and 66 students from School of General Studies.

2.5.3 Stage 3: Students were proportionally selected from the selected departments

In this stage, students were proportionally selected using systematic random sampling technique according to the number of students in each of the listed departments in the selected schools/faculties.

Stage 4: *Eligible students who consented to participate were enrolled until the required sample size was reached*. This approach helped ensure that respondents were selected from different sections of the student population rather than relying entirely on convenience sampling.

2.6 Inclusion Criteria

2.6.1 The study included:

- Registered students of Federal Polytechnic Nekede aged between 18 years and above
- Students who gave informed consent
- Students who were available during the study period and able to participate in the required visual assessments.

2.6.2 Exclusion Criteria

The study excluded:

- Students who declined consent
- Students who had ocular conditions that prevented reliable binocular vision testing
- Students who had a history of ocular surgery that could significantly affect the assessment
- Students who were unable to complete the required tests
- Students who had incomplete academic records/questionnaires.

2.6.3 Instruments for Data Collection

The following instruments were used: (i) Snellen visual acuity chart (ii) Trial frame (iii) Occluder (iv) Penlight (v) Near fixation target (vi) RAF rule (vii) Accommodative target (viii) Prism bar (ix) Maddox rod (x) Cover test tool (xi) Near vision chart (xii) Stereo test booklet (xiii) Red-green filtered lenses (xiv) Academic record/CGPA (xv) Data extraction sheets

2.7 Validity of Instruments

The instruments and clinical procedures used for assessing binocular vision were selected based on established optometric clinical standards. The data extraction sheet was reviewed by experts in optometry to ensure adequate coverage and clarity of the study variables. Academic performance was assessed using students' reported GPA/CGPA.

2.8 Reliability of Instruments

To enhance reliability, all instruments were checked for proper functioning and the researcher and research assistants were familiarized with standardized testing and recording procedures before data collection. Uniform testing distances, instructions, and procedures were maintained throughout the study to minimize measurement errors and ensure consistency of findings.

2.9 Method of Data Collection

The 3 schools were contacted to obtain permission from the school's Dean to conduct the research. Meetings were held in which number of participants, distribution of consent forms and choosing an appropriate room to conduct the vision tests were discussed. Consent forms included information about the study's purpose and the nature of the tests to be performed. Only students with signed consent participated in the study. Data extraction sheets were used to record all data.

2.9.1 Vision tests

Visual acuity (VA) test- As a rule of thumb, the researcher found it crucial to take entry VA of participants before any vision test was performed on them. The Snellen visual acuity chart was used to record VA. The students were instructed to sit on a chair placed 6 ft away from the chart. Visual acuity was assessed monocularly. A trial frame was placed on the participant, and an occluder was inserted to cover one eye while the visual acuity of the uncovered eye was assessed. The procedure was repeated for the fellow eye and then binocularly. Participants were instructed to read the smallest line of letters they could identify accurately, and the visual acuity was recorded for each eye and for both eyes.

If the participant had spectacle correction, VA was taken using this correction. All results were recorded on the data extraction sheet.

Titmus Stereo-fly- The student was instructed to sit; the test and its purpose were explained. They were instructed to wear red-green filtered lenses and the book was held in front of them. They were then asked to describe what they saw, once the butterfly was seen, they continued to each set of circles beneath where they would indicate which one popped out. The students continued for the rest of the sets until all were read or until it couldn't be distinguished which of the circles were popping out. The results were then recorded on the data extraction sheet.

Near point of convergence(NPC) test- The student was instructed to sit and the raff rule, the dot and line were shown to the student and the test explained to them where they were told to always focus on the target (the dot). Starting at 40 cm, the target was slowly pushed forward. The students were instructed to indicate when it gets blurry, when the line splits into two, where it was pulled back, and the student indicated when it got clear again. The test was repeated three times for accuracy and an average was recorded in cm on the data extraction sheet.

Amplitude of accommodation (AA) test - The student was instructed to sit, and the test and its purpose were explained. They were asked to keep their focus on the target line. The student was given an occluder and instructed to cover one eye. The target was moved to 40 cm and slowly pushed towards the nose. The students were told to indicate when it first gets blurry and cannot be cleared within 2-3 seconds. The same procedure was done for the other eye, and then both eyes. The results were recorded in diopters on the data extraction sheet.

Cover test (CT) – The students were instructed to sit and fixate on the given distant target. The occluder was held in front the eye for a few seconds and then removed. The non occluded eye was observed. Alternating cover test was then performed where each eye was covered for 3 seconds each by the occluder, going back and forth. Both occluded and non occluded eyes were observed. Prism bars were used to measure any deviation seen. The same procedure was carried out using a near target at 40 cm. The results were recorded for distance and near on the data extraction sheet.

Negative Fusional Vergence (NFV) test- Using a prism bar, the students were given their appropriate refractive correction. A binocular fixation target was presented at 40 cm for near. Base-in prism was gradually introduced. The students were asked to report when the target becomes blurred. The prism was continuously increased until the student reports double or inability to maintain fusion. The prism was gradually reduced until single vision returned. The three values were recorded as blur, break, recovery.

2.9.2 BVA Classification

Participants whose test results fell outside the predetermined normal clinical criteria were classified as having a binocular vision disorder.

- Accommodative Insufficiency- Characterized by reduced amplitude of accommodation lower than Hofstetter's calculation for minimum amplitude. (Based on Age Amplitude Min formula).
- Convergence Insufficiency-. Characterized by a reduced near point of convergence where the break value is more than or equal to 10 cm.
- Near Esophoria with inadequate Negative fusional vergence (NFV) - Characterized by a reduced negative fusional vergence where the NFV break value is less than twice the phoria in prism dioptres.
- Reduced stereoacuity- Characterized by a stereoacuity value more than 100 seconds of Arc.

2.9.3 Measurement of Academic Performance

Academic performance was assessed using the participant's most recent semester CGPA as obtained from the Heads of the various departments sampled. For the analysis:

CGPA	Category
≥ 2.50	Higher academic performance
< 2.50	Lower academic performance

2.10 Data Analysis

Data were entered and analyzed using SPSS version 23. Descriptive statistics included frequencies and percentages. The chi-square test was used to determine the association between binocular vision disorder status and academic performance. Statistical significance was set at $p < 0.05$

2.11 Ethical consideration

Ethical approval was obtained from the Research Ethics Committee, School of Health and Related Technology, Federal Polytechnic Nekede, Owerri. Written informed consent was obtained from participants. Confidentiality and anonymity were also maintained.

3 RESULTS

Socio-demographic Characteristics of Respondents

A total of 440 students participated in the study.

Table 1: Distribution of respondents according to age

Age group	Frequency	Percentage (%)
18–20	120	27.3
21–23	186	42.3
24–26	96	21.8
27 and above	38	8.6
Total	440	100.0

Table 1 above shows that the largest proportion of respondents, 186 (42.3%), were aged 21–23 years.

Table 2: Distribution According to Sex

Sex	Frequency	Percentage (%)
Male	166	37.7
Female	274	62.3
Total	440	100.0

Table 2 shows that there were 166 (37.7%) males and 274 (62.3%) females.

Table 3: Objective 1: Prevalence of Binocular Vision Disorders among Students of Federal Polytechnic Nekede, Owerri

Binocular vision status	Frequency	Percentage (%)
No binocular vision disorder	308	70.0
Binocular vision disorder present	132	30.0
Total	440	100.0

The findings showed that 132 (30.0%) participants had at least one binocular vision disorder, while 308 (70.0%) had no identified disorder.

Table 4: Types of Binocular Vision Disorders among Students of Federal Polytechnic Nekede, Owerri

Type of binocular vision disorder	Frequency	Percentage (%)
Convergence insufficiency	52	39.4
Accommodative insufficiency	40	30.3
Reduced Stereoacuity	28	21.2
Near Esophoria with inadequate NFV	12	9.1
Total	**132**	**100.0**

Interpretation: Among the 132 participants with binocular vision disorders, convergence insufficiency was the most frequently identified disorder, accounting for 52 (39.4%).

Table 5: Academic Performance of Students (n=440)

Academic performance	Frequency	Percentage (%)
Higher performance (GPA ≥ 2.50)	290	66.0
Lower performance (GPA < 2.50)	150	34.0
Total	440	100.0

Objectives 2, 3 &4 : Academic Performance of Students with Binocular Vision Disorder and without Binocular Vision Disorder

Table 6: Relationship between binocular vision disorders and academic performance

Binocular vision status	Lower Academic performance	Higher Academic performance	Total
Disorder present	83 (62.9%)	49 (37.1%)	132
No disorder	67 (21.8%)	241 (78.2%)	308
Total	150	290	440

$\chi^2 = 69.55$, df = 1, $p < 0.001$

Interpretation

Among the 132 students with binocular vision disorders, 83 (62.9%) had lower academic performance, while 49 (37.1%) had higher academic performance. Among students without binocular vision disorders, 67 (21.8%) had lower academic performance, while 241 (78.2%) had higher academic performance. The chi-square test showed a statistically significant association between binocular vision disorder status and academic performance:

4 DISCUSSION

4.1 Prevalence of Binocular Vision Disorders among the Students

This study found that 132 (30.0%) of the 440 students examined had at least one binocular vision disorder with convergence insufficiency being the most common disorder accounting for 52 (39.4%). This finding is consistent with the study by Ovenseri-Ogbomo and Eguegu (2016), conducted among 212 first-year university students in Benin City, Nigeria, which reported a prevalence of 12.7% for vergence dysfunctions, with convergence insufficiency being the most common disorder. Although the prevalence reported in that study was lower than the 30.0% found in the present study, the difference may be due to differences in the diagnostic criteria, study populations, age distribution, and the range of binocular vision disorders assessed. While the Benin City study focused particularly on vergence dysfunctions, the present study dwelt on binocular vision disorders more broadly. Similarly, Alghamdi et al. (2022) reported that binocular vision anomalies were common among university students in Saudi Arabia. Their study of 109 university students discovered heterophoria in 45.8% of participants. Their study assessed binocular vision using cover testing,

near point of convergence, and stereopsis, among other measures. The relatively high prevalence reported in their study is in line with the observation that binocular vision anomalies are common among tertiary-level students.

Another study by Alhassan et al. (2025) investigated non-strabismic binocular vision anomalies among 304 university students in Saudi Arabia and reported a prevalence of 50% for vergence anomalies and 33.5% for accommodative anomalies. Their study emphasized the importance of comprehensive optometric assessment because abnormalities may be present even when visual acuity is normal. The 30.0% prevalence obtained in the present study therefore falls within the broad range reported in student populations, although direct comparisons should be made cautiously because different studies use different definitions and diagnostic criteria for binocular vision disorders. Ovenseri-Ogbomo and Eguegu (2016) similarly emphasized the importance of thorough binocular vision assessment among university students because previously undiagnosed vergence dysfunctions may influence academic activities.

4.2 Relationship Between Binocular Vision Disorders and Academic Performance

The principal finding of this study was that there was a statistically significant association between binocular vision disorders and academic performance among students of Federal Polytechnic Nekede. This finding is supported by Gawde et al. (2026) who investigated the functional consequences of binocular vision anomalies in college students. The authors concluded that convergence insufficiency was associated with reduced performance on routine near-work activities. Phillips (2017) similarly reported that convergence insufficiency is frequently associated with symptoms during near fixation activities such as reading and has been linked in some studies with reading difficulties and academic performance. Importantly, Phillips cautioned that an association between convergence insufficiency, reading difficulties, and academic performance does not by itself establish a causal relationship. The present study therefore contributes to the existing literature by demonstrating a statistically significant relationship between the broader category of binocular vision disorders and an educational outcome (academic performance) within a Nigerian tertiary institution.

Although the present study found a statistically significant association between binocular vision disorders and academic performance, not all previous studies have reported a similar relationship. Alghamdi et al. (2022), in their study of young university students in Saudi Arabia, found that binocular vision anomalies were common, with heterophoria present in 45.8% of participants. However, academic performance was not statistically different between students with heterophoria and those with orthophoria. Remarkably, the researchers found significant differences in convergence insufficiency symptom survey and stereopsis scores between the groups. The difference between the findings of Alghamdi et al. (2022) and the present study may be explained by differences in study design, sample size, classification of binocular vision disorders, assessment of academic performance, and features of the respondents. The Saudi Arabian study compared academic performance between students classified according to heterophoria status, whereas the present study considered students with at least one binocular vision disorder as a group. In addition, academic performance may be influenced by numerous factors that differ between educational institutions and populations. The findings of Alghamdi et al. (2022) thus show that the presence of a binocular vision anomaly does not necessarily represent tangible differences in academic performance in every student population. Some students may compensate sufficiently for their binocular vision anomaly, while others may experience symptoms or functional difficulties that interfere more significantly with academic tasks.

5 CONCLUSION

This study investigated the relationship between non-strabismic binocular vision disorders and academic performance among students of Federal Polytechnic Nekede, Owerri. The study revealed a statistically significant association between binocular vision disorders and academic performance. The findings suggest that binocular vision disorders are an important visual health consideration among students of tertiary institution. The result is supported by evidence that some binocular vision disorders, particularly convergence insufficiency, can be associated with difficulties in sustained near-work activities such as reading and writing. Nevertheless, given that this study was cross-sectional, the observed association should not be interpreted as proof that binocular vision disorders cause poor academic performance. The study concludes that adequate attention should be given to binocular vision assessment as part of comprehensive eye care for students, especially those experiencing visual symptoms during academic activities.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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