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## Normative values for jump convergence among young adults

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### Article Publication Details

This article is published in the **International Journal of Multidisciplinary Research and Bulletin**, ISSN 3108-1428 (Online) Volume 5 Issue 2 (Mar – Apr) 2026.

### ABSTRACT

Jump convergence is an expression of the quality of ocular convergence at play when binocular visual focus moves quickly from a distant target to a near target in a jump/phasic motion. It is also known as saccadic or phasic convergence and is regarded as a measure of the adaptability and reflex control of the binocular vergence mechanism. Jump convergence ability is vital in binocular vision assessments and it is of critical importance as a training protocol in rehabilitative vision therapy. Practically, the demand for jump convergence closely mirrors typical viewing situations where fixation is continually shifting between near and far targets, making jump convergence ability important for everyday tasks. This study assessed the jump convergence ability of a sample size of 170 young adults aged 16 – 30 years, within the Imo State University, Owerri campus, in order to determine normative values of jump convergence among young adults with normal binocularity. The jump convergence for each participant was assessed using the test target of size N6 and the results were analysed by descriptive statistics to determine the normative value of jump convergence for the age group. The mean jump convergence for the sample size was determined as 39.58 cpm (std. dev = 8.241), 40.13 cpm (std. dev = 8.51) for the male and 39.03 cpm (std. dev = 8.06) for females. The study concludes that the normative jump convergence among the sample size is 39.58cpm ( $\pm 8.241$ ) and recommends further studies on normative values for jump convergence among young adults of other extractions.

**Keywords:** jump convergence, accommodative target, binocular vision, saccadic convergence, vision therapy, normative.

### Introduction

Comfortable binocular vision requires functional convergence ability. It can be expressed as a gradual convergence movement of the eyes focused on a target as it gradually approaches the

observer (pursuit convergence) or as a quick convergence jump movement as the fixation changes from a distant target to a near target (jump convergence).<sup>1, 2, 3</sup>

Jump convergence is expressed when the binocular fixation on a target moves quickly from a distant or mid-distant target to a near target forming a saccadic or phasic motion.<sup>4</sup> It may also be referred to as step vergence due to the sharp nature of the eye convergence movement as it switches focus from far to near.<sup>5</sup> Compared to pursuit convergence, jump convergence is more likely applied in real life activities<sup>1, 2</sup> and it has been identified as particularly useful in vision therapy protocols especially in the latter stages as it helps the patients develop their ability to adapt to the changing visual demands in everyday life.<sup>6</sup> As a tool for vision therapy, jump convergence is stimulated using the phasic/jump vergence training method, where fixation (vergence demand) is quickly changed alternately and in large steps to elicit a jump convergence movement.<sup>7</sup> Studies have confirmed that jump convergence exercises (involving phasic vergence training) are very effective as vision therapy interventions in fusional vergence dysfunctions, with significant improvements in vergence abilities after the therapy trainings.<sup>7</sup> In addition to therapy exercises, jump convergence assessment plays a significant role in the detection and diagnosis of binocular vision/convergence anomalies.<sup>3</sup>

Although very vital in both the diagnosis and therapy protocols for binocular vision anomalies, jump convergence test findings are not popularly considered in the diagnosis of convergence insufficiency unlike pursuit convergence, probably due to its qualitative rather than quantitative nature.<sup>4</sup> Compared to pursuit convergence (near point of convergence), there is not much data regarding jump convergence assessment normative values and details regarding the targets used for its assessment readily available.<sup>4</sup>

### **Purpose of study**

Unfortunately, jump convergence has not yet been subjected to the same intensity of research evaluation that pursuit convergence has, hence there is a paucity of information regarding normative values for jump convergence ability. The lack of available expected values for the jump convergence test is a draw-back for the adoption of jump convergence testing in routine clinical convergence assessment protocols, especially among the African population.<sup>4, 8</sup> The determination of normative values for jump convergence for the study population will contribute to existing knowledge base.

### **Aim and objectives of the study**

The aim of the study was to determine the normative values of jump convergence among young adults. The Objectives included:

- i. To assess the jump convergence of normal binocularity subjects aged 16 – 30 years, using single letter near test target of N6
- ii. To determine the normative jump convergence results among subjects with normal binocularity aged 16 – 30 years, with respect to gender
- iii. To determine the normative jump convergence results among subjects with normal binocularity aged 16 – 30 years, with respect to age class.

### Significance of study

The availability of normative data in clinical care is very critical; it serves to establish classifications of pathologies that are vital for proper diagnosis, as well as influencing standards of care that may be applied in setting treatment targets and monitoring treatment outcomes.<sup>9</sup> To achieve accurate diagnosis and management protocols, reference to the normative data specific to the patient's population is necessary.<sup>8</sup> Unfortunately, compared to pursuit convergence, not much data regarding jump convergence assessment normative values and details regarding the targets used for its assessment are readily available.<sup>4</sup> The study findings reveal the normative values for jump convergence among 16 – 30 year olds with normal binocularity in Imo state university, Owerri, Nigeria, with respect to gender and age and it contributes to existing body of information about jump convergence. This normative data for jump convergence is helpful to clinicians for proper diagnostic assessment, also serving as a benchmark for setting for vision therapy rehabilitation goals and helpful in the monitoring of progress achieved in building vergence facility during therapy.

### MATERIAL AND METHODS

This study was carried out within the campus of Imo State University, Owerri, Imo State, Nigeria, using a cross sectional study design in which the jump convergence of young adults aged 16 – 30 years were assessed using accommodative test target. The study population was comprised of black African young adults of the Igbo tribe of the South eastern region of Nigeria, undergraduates in the Imo State University campus, situated in Owerri, the capital city of Imo state, Nigeria. Out of 470 interested candidates who were pre-screened, a total number of 296 eligible participants met the inclusion criteria. The study sample size of 170, derived using the Yamane formula<sup>10</sup> with a 95% confidence interval, was drawn from healthy participants aged 16 - 30 years old, comprising of both male and female, who met the inclusion criteria was used for this study.

Ethical approval to conduct the study within the campus was obtained and permission to utilise the Optometry clinic for the study was granted by the research and ethics committee of the college of

medicine and the Optometry department, Imo state University, respectively. All the willing participants were duly informed of the various test procedures to be performed for the research study. Only the candidates who voluntarily gave their written informed consent to participate in this study were assessed for data collection. Furthermore, the anonymity and confidentiality of all the research respondents was maintained throughout the data collection and analysis process of the study.

All interested participants were pre-screened to ascertain their eligibility for the study – a short questionnaire was administered to identify demographic information such as age, sex, systemic case histories, and ocular case histories. Furthermore, preliminary vision screening for assessing ocular motility, binocularity, and refractive status were performed on all the participants. Based on the exclusion criteria, candidates with visual binocularity anomalies, high refractive errors, amblyopia, best corrected visual acuity that is worse than 6/12 in either eye, history of ocular trauma or surgery, current use of ocular or systemic drugs that may affect accommodation and binocular vision, were excluded from the study.<sup>11</sup>

All the participants in the study sample were assessed for jump convergence ability using the near chart single Snellen letters of the size N6 (20/40), as the test target in free space.<sup>12</sup> Each of the participants had the jump convergence test repeated thrice and the mean value adopted to ensure reliability. For the test, the subject was seated comfortably with head positioned upright before the examiner and a distant visual acuity chart positioned 60cm away. The near test target was then positioned before the subject at 20cm. The proper testing conditions were in place such as adequately illuminated exam room, refractive correction of the subject (if any) in place, and no obstructions of subject's view of the distant target. The subject was then required to focus on the distant visual acuity chart at a given single letter of a size that is one line better than his best distant visual acuity in his poorer eye (as determined during the pre-screening). With the Royal airforce (RAF) rule in place, the test target N6 was then positioned before the subject, at 20cm from the subject, the subject was then required to alternately focus with both eyes in a slightly downward gaze, at the near target (20cm) and then quickly at the far target (60cm) and back again at the near target (comprising of one cycle), continually, for a period of 1minute. This process was observed and noted by the examiner to determine the number of cycles completed within 1 minute (cpm), as well as the accuracy, speed and smoothness of the focus changes from near to far demonstrated by each candidate.<sup>5</sup>

The data generated were categorised according to gender and age classes based on the study objectives, to facilitate analysis. Descriptive statistical analysis such as frequency distribution,

central tendencies and variability were applied to the generated data at 5% level of significance with probability value ( $p < 0.05$ ) and 95% confidence level.

**RESULTS**

The sample size of 170 young adults, aged 16 – 30 years was assessed for jump convergence in this study. The average age of the sample size was determined as 22.2 years ( $\pm 3.26$ ). The males among them accounted for 41.2% of the sample size (70) whereas 58.8% (100) of the study sample were female. All of the participants were undergraduate scholars and black African of the Igbo tribe of south east Nigeria.

The mean, standard deviation, minimum values and maximum values of the jump convergence were determined. The jump convergence (JC) values recorded for the study sample using N6 target was determined as 39.58 cpm (std. dev = 8.241). According to gender categorization (Table 1), the mean JC value for the male was 40.13 cpm (std. dev = 8.51) and for female was 39.03 cpm (std. dev = 8.06). According to age class (Table 2), mean jump convergence was highest among subjects aged 20 – 22 years of age at 42.93 cpm (std. dev = 8.89) and the least among subjects aged 25 – 28 years, at 38.50 cpm (std. dev = 2.08).

**Table 1: Jump convergence distribution according to gender**

Gender	N	Mean JC (cpm)
		$\pm$ st.d
Male	70	40.13 $\pm$ 8.51
Female	100	39.03 $\pm$ 8.06

**Table 2: Jump convergence values according to age class**

Age Class	N	JC (cpm)
		mean $\pm$ st.d
$\leq 19$	44	39.61 $\pm$ 8.22
20 – 22	39	42.93 $\pm$ 8.89
23 – 25	43	39.69 $\pm$ 8.70
25 – 28	40	37.11 $\pm$ 6.99
28+	4	38.50 $\pm$ 2.08

**DISCUSSION**

Normative data refers to values that define the usual or expected outcomes within a specific population and is often summarized by the mean of data generated within a specific population.<sup>9</sup> Such normative data is associated with specific population-expected outcomes as it may vary from population to population.<sup>8</sup> Review of available literature on the normative values of jump convergence revealed a paucity of information about established normative values for jump

convergence,<sup>4</sup> with few of binocular vision related studies on normative values conducted on African populations.<sup>8</sup> The study by Schieman *et al.*<sup>13</sup> recorded a mean jump convergence of 30 cpm ( $\pm 10$ ) for subjects with normal binocular vision and a mean jump convergence of 23 cpm ( $\pm 11$ ) for subjects with convergence insufficiency. The outcomes of this study reveal the average values of jump convergence measurements as 39.58 cpm (st. dev = 8.241) among Nigerian young adults aged 16 – 30 years, using size N6 test target. Although this value is higher than the values recorded in the study among the normal binocularity subjects by Schieman *et al.*<sup>13</sup>, the sample size for this study is 170 compared to 10 in the study by Schieman *et al.*<sup>13</sup> In another study by Scheiman *et al.*<sup>14</sup> to access repeatability of various clinical vergence testing protocols, the mean jump convergence among adolescents aged 12 – 17.5 years was determined as 26.4 jumps per minute ( $\pm 7.1$ ); the study sample size of this research was also below 100.

## CONCLUSION

Normative data is vital for proper clinical diagnosis and care and such data is peculiar to specific populations/groups with unique characteristics. The outcomes of this study show that the mean jump convergence among young African adults is 39.58 cpm (std. dev = 8.241), among the males 40.13 cpm (std. dev = 8.51) and 39.03 cpm (std. dev = 8.06) for females. Those within the age class of 20 – 22 years had the highest jump convergence scores (42.93 cpm (std. dev = 8.89)). The adoption of jump convergence assessment during routine binocular vision assessments of young adults is recommended as part of protocols for the timely detection of binocular vision dysfunctions. Furthermore, more research on the normative values for jump convergence among young adults of other extractions is recommended.

### Article History

Received: 15-Apr-2026

Accepted: 22-Apr-2026

Published: 24-Apr-2026

### **Article Publication Details** (*rpt\**)

This article is published in the [International Journal of Multidisciplinary Research and Bulletin](#), ISSN 3108-1428 (Online). In Volume 5 Issue 2 (Mar – Apr) 2026

The journal is published and managed by [IRPG](#).

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### **Acknowledgements**

We sincerely thank the editors and the reviewers for their valuable suggestions on this paper.

### **Funding**

The authors declare that no funding was received for this work.

### **Data availability**

No datasets were generated or analyzed during the current study.

### **Declarations**

#### **Ethics approval and consent to participate**

Approved

#### **Consent for publication**

The author(s) declare that this is not applicable.

#### **Competing interests**

The author(s) declare that they have no competing interests.

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