

# Relationship between pupil to limbus diameter ratio with blood pressure and pulse rate in young adults: An observational study



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## ABSTRACT

**Background:** Autonomic function tests play a crucial role in the diagnosis and prognosis of clinical conditions. Although there are multiple autonomic function tests available, there is still a need for rapid and less expensive tests for the benefit of the general population. The pupil-to-limbus diameter (PLD) ratio is one such test that is simple and cost-effective. It uses the principle of pupil dilation and constriction due to the influence of the autonomic neurons' activity. **Aims and Objectives:** The present study aimed to observe a correlation between PLD ratio with blood pressure and pulse rate in young adults. **Materials and Methods:** The present study was conducted at the Department of Physiology, Jhalawar Medical College, Jhalawar. The present study was an observational study conducted among 1<sup>st</sup>-year medical students in the age group of 18–24 years. PLD ratio was measured by the two-box method as described in the literature. After providing 3–5 min of rest, blood pressure and pulse were recorded in the right arm in the sitting position by a digital blood pressure monitor. **Results:** Positive correlation was observed between the PLD ratio of right eye and pulse rate ( $r=0.9696$ ). There is a weak negative correlation exists between the PLD ratio of right eye and systolic blood pressure ( $r$  value =  $-0.3802$ ). **Conclusion:** The study concludes that the PLD ratio correlates with autonomic activity. However, there is a need for a study with large population to confirm the correlation. Furthermore, there is a study to assess the autonomic responses in female participants in different phases of menstrual cycle.

**Key words:** Pupil to limbus diameter ratio; Autonomic functions; Pulse rate; Systolic blood pressure

## INTRODUCTION

Autonomic function tests play a crucial role in the diagnosis and prognosis of clinical conditions. Although there are multiple autonomic function tests available, there is still a need for rapid and less expensive tests for the benefit of the general population. The pupil-to-limbus diameter (PLD) ratio is one such test that is simple and cost-effective.<sup>1</sup> It uses the principle of pupil dilation and constriction due to the influence of the autonomic neurons' activity.<sup>2,3</sup> The pupil, an aperture located in the center of the iris of the eye regulates the entry of light into the retina. The limbus

constitutes the border between the white opaque sclera and transparent cornea.<sup>1</sup> The size of the pupil is controlled by the activities of two muscles: the circumferential sphincter muscle found in the margin of the iris, innervated by the parasympathetic nervous system: and the iris dilator muscle, running radially from the iris root to the peripheral border of the sphincter.<sup>4-6</sup> The iris dilator fibers contain  $\alpha$ -adrenergic sympathetic receptors that respond to changes in sympathetic tonus and changes in the blood level of circulating catecholamines.<sup>2</sup> Increased sympathetic activity increases the activity of the dilator muscle, prompting dilation, whereas inhibition of parasympathetic activity

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lessens constriction of the sphincter muscle, which also results in dilation. Thus, increases in pupillary diameter can be mediated by activity in either division of the autonomic nervous system.<sup>3</sup> The present study aimed to observe the correlation between PLD ratio with blood pressure and pulse rate in young adults.

### Aims and objectives

The present study aimed to observe the correlation between PLD ratio with blood pressure and pulse rate in young adults.

## MATERIALS AND METHODS

The present study was conducted at the Department of Physiology, Jhalawar Medical College, Jhalawar. The present study was an observational study conducted among 1<sup>st</sup>-year medical students in the age group of 18–24 years, who were volunteered and ready to give written informed consent. One hundred participants were recruited for the study. Willing and healthy individuals were recruited for the study. Those who are under any medication that affects the blood pressure and those who are having any eye disorders like glaucoma were excluded from the study. After obtaining the informed consent, the demographic data and the vitals were recorded. The pictures of both eyes were taken as per the literature. The study protocol was cleared by the institutional human ethical committee. All the parameters were collected between 9 and 10 am to avoid diurnal variation.

### Assessment of PLD ratio

PLD ratio was measured by two-box method as described in the literature.<sup>1</sup> PLD was measured at constant illuminance for all the participants. Illuminance measurement for the ambient light conditions was made using a Luxmeter and the images were captured using a high-resolution camera. Before capturing the image of the eye, the participants were exposed to the ambient light for at least 5 min.

### Assessment of blood pressure and pulse rate

After providing 3–5 min of rest, blood pressure and pulse was recorded in the right arm in the sitting position by a digital blood pressure monitor.<sup>4</sup>

### Statistical analysis

Data were analyzed by SPSS 27.0 version. Data were checked for quality control in a spreadsheet and then expressed in mean and standard deviation. Pearson Correlation test was used to observe the correlation. A probability value of <0.05 was considered significant.

## RESULTS

Table 1 presents the demographic data of the study participants. Table 2 presents the correlation of PLD ratio of the right eye with pulse rate, systolic blood pressure (SBP) and diastolic blood pressure (DBP). Positive correlation was observed between the PLD ratio of right eye and pulse rate ( $r=0.9696$ ). There is a weak negative correlation exists between the PLD ratio of right eye and SBP ( $r=-0.3802$ ). There is a weak negative correlation exists between the PLD ratio of right eye and DBP ( $r=-0.2742$ ). Table 3 presents the correlation of PLD ratio of left eye with pulse rate, SBP, and DBP. There is a weak positive correlation exists between the PLD ratio of left eye and DBP ( $r=0.3752$ ). There is a weak negative correlation exists between the PLD ratio of right eye and SBP ( $r=-0.2567$ ). Positive correlation was observed between the PLD ratio of left eye and pulse rate ( $r=0.112$ ).

## DISCUSSION

The present study aimed to observe the correlation between PLD ratio with blood pressure and pulse rate in young

**Table 1: Demographic parameters of the participants**

Parameter	Mean and SD
Age (years)	20±2
Height (cm)	164±28
Weight (kg)	58±12

Data was expressed as mean and SD

**Table 2: Correlation of PLD ratio of right eye with pulse rate, SBP, and DBP**

PLD ratio (right eye)	Pulse rate (beats/min)	SBP (mmHg)	DBP (mmHg)
0.49±0.1584	82.4±12.75	124±9.3	74.8±6.09
	$r=0.9696$	$r=-0.3802$	$r=-0.2742$
	$P<0.00001$	$P=0.000096$	$P=0.006594$

Data was expressed as mean and SD, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, PLD: Pupil-to-limbus diameter

**Table 3: Correlation of PLD ratio of left eye with pulse rate, SBP, and DBP**

PLD ratio (right eye)	Pulse rate (beats/min)	SBP (mmHg)	DBP (mmHg)
0.45±0.122	82.4±12.75	124±9.3	74.8±6.09
	$r=0.112$	$r=-0.2567$	$r=0.3752$
	$P=0.267252$	$P=0.01014$	$P=0.00012$

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, PLD: Pupil-to-limbus diameter

adults. A positive correlation was observed between the PLD ratio of the right eye and pulse rate. There is a weak negative correlation between the PLD ratio of the right eye and SBP. There is a weak negative correlation between the PLD ratio of the right eye and DBP. There is a weak positive correlation between the PLD ratio of the left eye and DBP. There is a weak negative correlation exists between the PLD ratio of the right eye and SBP. A positive correlation was observed between the PLD ratio of the left eye and pulse rate.

Autonomic function tests evaluate the severity and distribution of autonomic failure and can detect autonomic dysfunctions.<sup>7</sup> Non-invasive quantitative tests are available to evaluate the cardiovascular activities, sudomotor axon reflex, and other autonomic function tests. Although there are multiple tests for evaluating autonomic functions, still there is a need of the development of affordable and quicker tests for the same.<sup>8</sup> PLD ratio is one such test to evaluate the autonomic functions.<sup>9</sup> Earlier studies reported a positive correlation between the PLD ratio and blood pressure and pulse rate.<sup>10-13</sup> The ratio can be measured by the two-box method. The pupil dilation and constriction are regulated by the autonomic activity. Hence, there is a clear correlation between the PLD ratio and autonomic functions. Earlier studies reported that there is a positive correlation between these two parameters and hence, the PLD ratio can indirectly estimate the autonomic activity. However, in the present study, the results were different. That is we have observed both positive and negative correlations with different eye ratios. The reason for this may be the earlier studies conducted were only in one gender either male or female.<sup>13,14</sup> However, the current study included both genders. Further, as female participants were involved in this, there may be the influence of cyclical changes in the hormones on autonomic activity. Changes in estrogen levels and progesterone levels may influence autonomic activity and that may be the reason for the change in the autonomic responses. As our objective is not to compare male and female responses, we have not done it. There is a strong need for observing the difference in the autonomic responses in females that too different phases of the cycle. The study concludes that the PLD ratio correlates with autonomic activity. However, there is a need for a study with large population to confirm the correlation. Furthermore, there is a study to assess the autonomic responses in female participants in different phases of menstrual cycle.

#### Limitations of the study

The sample size of the study was small. Hence, results cannot be generalized.

## CONCLUSION

The study concludes that the PLD ratio correlates with autonomic activity. However, there is a need for a study with large population to confirm the correlation. Furthermore, there is a study to assess the autonomic responses in female participants in different phases of menstrual cycle.

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**Authors' Contributions:**

**HS**- Design of the study, review of literature, analysis and preparing the manuscript; **IK**- Data collection, preparing the manuscript; **VP, HK**- Analysis and preparing the manuscript.

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