

# Perceived Stress and Executive Functioning Assessed by Colour Trail Test in Normal Adult Population: A Cross-Sectional Study from Eastern India

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## Abstract

**Background:** Perceived stress is known to influence executive cognitive functions, particularly attention, processing speed, and cognitive flexibility. The Color Trail Test (CTT) is a culturally sensitive neuropsychological tool widely used to assess these domains. However, data examining the relationship between perceived stress and CTT performance in normal Indian adults remain limited. The aim is to assess perceived stress levels in a normal adult population and examine their relationship with executive functioning as measured by the Color Trail Test. **Material and Methods:** This cross-sectional study was conducted on 136 healthy adults recruited from a tertiary care setting. Perceived stress was assessed using the Perceived Stress Scale (PSS). Executive functioning was evaluated using the Color Trail Test, including CTT-1, CTT-2, wrong attempts, difference score, proportion score, and ratio score. Socio demographic variables were recorded. Statistical analysis was performed using SPSS. Group differences were assessed using t-tests and ANOVA, and relationships between perceived stress and CTT parameters were examined using Pearson's and Spearman's correlation coefficients. **Results:** The mean PSS score was  $21.28 \pm 5.98$ , indicating moderate perceived stress. Female participants reported significantly higher perceived stress than males ( $p = 0.008$ ). Significant differences in PSS scores were observed across religious groups ( $p = 0.003$ ). Correlation analysis revealed significant positive associations between PSS scores and CTT-2 time, CTT difference score, proportion score, and ratio score, suggesting poorer executive performance with higher perceived stress. No significant association was found between PSS and CTT-1 time or wrong attempts. **Conclusion:** Perceived stress is significantly associated with higher-order executive dysfunction as assessed by complex Color Trail Test parameters in healthy adults. These findings highlight the subtle impact of perceived stress on executive control even in non-clinical populations.

**Keywords:** Perceived stress, executive function, Color Trail Test, normal population, psychiatry.

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## INTRODUCTION

Stress is an integral component of human experience and plays a central role in mental health and cognitive functioning. In psychiatry, increasing emphasis has been placed on perceived stress, which refers to an individual's subjective appraisal of stressors rather than objective life events. The Perceived Stress Scale (PSS), developed by Cohen and colleagues, is one of the most widely used instruments for measuring this construct and has demonstrated good psychometric properties across cultures, including Indian populations.<sup>[1]</sup>

From a neurobiological perspective, stress exerts its effects primarily through activation of the hypothalamic–pituitary–adrenal (HPA) axis and subsequent glucocorticoid release. Chronic or sustained stress exposure has been associated with functional and structural changes in brain regions involved in executive control, particularly the prefrontal cortex. These changes may manifest as impairments in attention, cognitive flexibility, processing speed, and inhibitory control.

Executive functions are higher-order cognitive processes that enable goal-directed behavior, adaptation to changing environments, and regulation of thoughts and actions. Neuropsychological assessment of executive functioning is therefore of significant relevance in psychiatric research. Initially, Color Trails Test was developed as a culturally fair analogue of the TMT.<sup>[2]</sup> However, it was not designed to produce equivalent or even similar time to completion scores when compared with the TMT, but rather to tap similar executive

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cognitive abilities and to allow broader cross-cultural applications. The Color Trail Test (CTT) is a culturally neutral adaptation of the Trail Making Test that minimizes the confounding effects of language and literacy.<sup>[3]</sup> CTT-1 primarily assesses visual scanning, attention, and psychomotor speed, while CTT-2 places greater demands on cognitive flexibility, divided attention, and executive control. The term “Interference Cost” is used as a measure of time taken to alternate between the colors and is given by CTT2 time minus the CTT1 time (CTT2-CTT1). There are some related ratios [CTT2/CTT1 ratio] and proportions [CTT difference/CTT1] which measures set-shifting/working memory activities after adjusting for basic scanning speed.<sup>[4]</sup> Previous research has consistently demonstrated executive dysfunction in psychiatric conditions such as depression, anxiety disorders, and schizophrenia. Stress has been proposed as a key mediator of these impairments. However, findings regarding the relationship between perceived stress and executive functioning in normal populations are mixed. Some studies suggest that moderate stress does not significantly impair cognition, whereas others report subtle deficits in complex executive tasks.<sup>[5]</sup>

In the Indian context, normative data examining perceived stress and its cognitive correlates remain scarce. Sociodemographic variables such as sex, religion, education, and social class may influence stress perception and cognitive performance. Establishing normative relationships between stress and executive functioning is essential for differentiating normal variations from pathological impairment.

The present study was therefore undertaken to assess perceived stress in a normal adult population and examine its association with executive functioning using detailed Color Trail Test parameters.

**MATERIALS AND METHODS**

**Study design:** This was a cross-sectional observational study

**Place of Study:** Conducted simultaneously at Department of Psychiatry, Jhargram Medical College, in addition to

Hastings College and David Hare Training College.

**Study Duration:** December 1, 2025 to 31 March, 2026

**Sample size:** A total of 136 healthy adults were included in the study. Participants were recruited from the community and hospital staff attendants by purposive sampling.

**Inclusion criteria**

- Age ≥18 years
- Apparently healthy individuals
- Ability to understand and complete the assessment tools

**Exclusion criteria**

- CGI-S(21): 1 or 0
- History of psychiatric illness
- Neurological disorders
- Substance dependence
- Significant medical illness which may affect cognition

**Tools used**

1. CGI-S(clinical global Impression-severity) - to exclude psychiatric illness
2. Perceived Stress Scale (PSS): A widely used self-report instrument assessing perceived stress over the past month.
3. Colour Trail Test (CTT):
  - CTT-1 time
  - CTT-2 time
  - Wrong attempts
  - Difference score (CTT-2 – CTT-1)
  - Proportion scorez
  - CTT Ratio score
4. Sociodemographic proforma: Included age, sex, religion, marital status, background, education, academic stream, profession, and social class.

**Ethical considerations:** Ethical approval was obtained from the institutional ethics committee. Written informed consent was obtained from all participants.

**Statistical analysis:** Data were analysed using SPSS software. Descriptive statistics were calculated for all variables. Independent-samples t tests and one-way ANOVA were used for group comparisons. Pearson’s and Spearman’s correlation coefficients were used to examine relationships between PSS scores and CTT parameters. A p value <0.05 was considered statistically significant.

**RESULTS**

**Table 1: Sociodemographic characteristics of the sample (N = 136)**

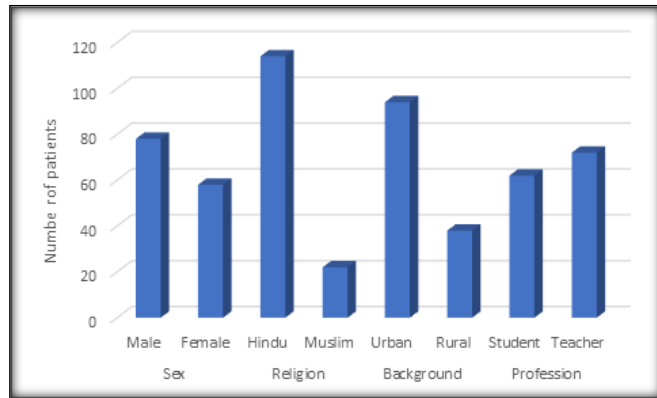
Variable	Category	n (%)
Sex	Male	78 (57.4)
	Female	58 (42.6)
Religion	Hindu	114 (83.8)
	Muslim	22 (16.2)
Background	Urban	94 (69.1)
	Rural	38 (27.9)
Profession	Student	62 (45.6)
	Teacher	72 (52.9)

**Table 2: Comparison of PSS scores across sex**

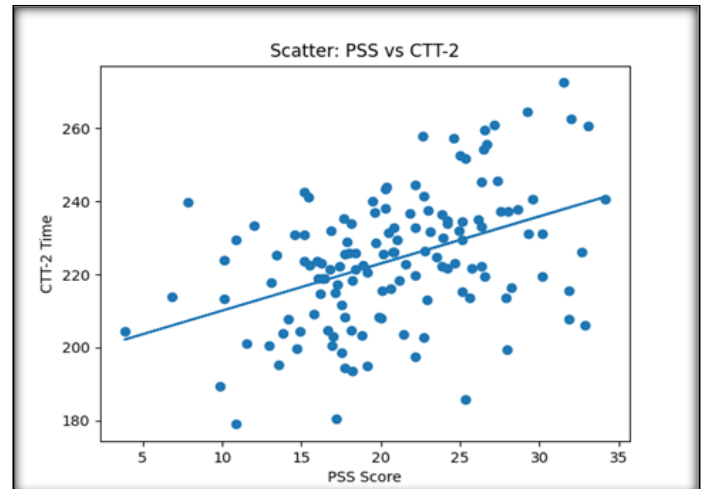
Variable	Category	N	Mean	Std. Deviation	Test Value	Sig. (2-tailed)
PSS Score (Overall)	Total	136	21.28	5.98		
Sex	Male	78	20.11	5.19	t = -2.67	0.008
	Female	58	22.83	6.6		
Religion	Hindu	114	22.1	6.1	t = 2.98	0.003
	Muslim	22	19.85	5.4		

**Table 3: Relationship between perceived stress and Color Trail Test performance**

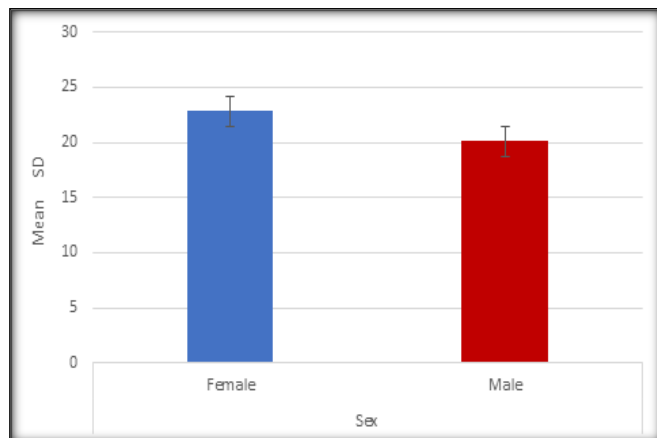
Variable	Correlation with PSS (Pearson's r)	Significance (p-value)	Association
CTT-1	0.171	0.051	Not significant
CTT-2	0.23	0.036	Significant positive
Difference score	0.221	0.042	Significant positive
Proportion score	0.224	0.04	Significant positive
Ratio score	0.264	0.015	Significant positive
Wrong attempts	-0.122	0.163	Not significant



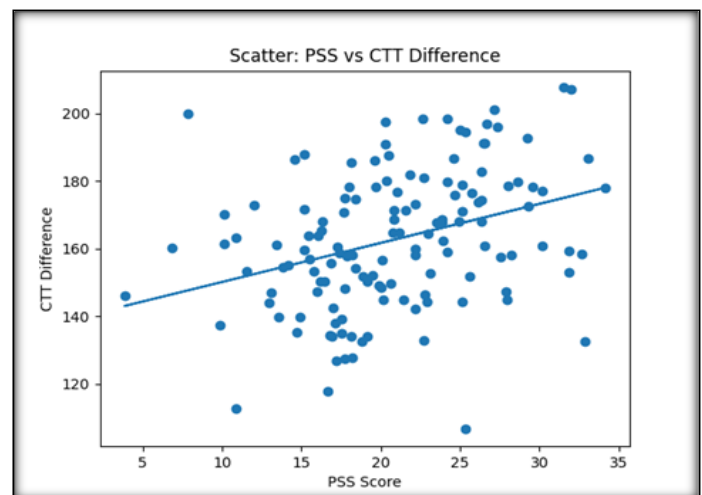
**Figure 1: Sociodemographic characteristics of the sample**



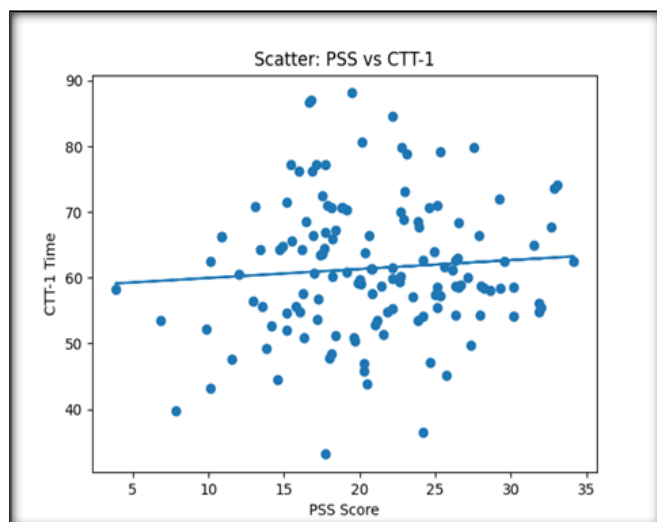
**Figure 4: Relationship between PSS and CTT-2 (significant positive association)**



**Figure 2: Scatter Plots: PSS vs CTT Variables**



**Figure 5: Relationship between PSS and CTT Difference score (significant positive association).**



**Figure 3: Relationship between PSS and CTT-1 (no significant association)**

**Socio demographic Characteristics:** A total of 136 participants were included in the final analysis. The socio demographic profile of the sample is presented using both tabular and graphical formats for clarity.

The sample consisted of 57.4% males (n = 78) and 42.6% females (n = 58). The majority of participants belonged to the Hindu religion (83.8%), while 16.2% were Muslim. Most participants were from an urban background (69.1%), and the remaining 27.9% were from rural areas.

Professionally, 52.9% were teachers and 45.6% were students.

**Perceived Stress Scores:** The mean PSS score of the total sample was  $21.28 \pm 5.98$ , indicating a moderate level of

perceived stress among participants.

**Sex-wise comparison:** Female participants demonstrated significantly higher perceived stress scores compared to male participants ( $22.83 \pm 6.60$  vs.  $20.11 \pm 5.19$ ;  $t = -2.67$ ,  $p = 0.008$ ).

**Religion-wise comparison:** A statistically significant difference in PSS scores was observed across religious groups ( $p = 0.003$ ), with Hindu participants reporting higher perceived stress compared to Muslim participants.

#### Relationship between perceived stress and Color Trail Test performance

##### Correlation analysis demonstrated:

- CTT-1: No significant association with PSS (Pearson's  $r = .171$ ,  $p = .051$ )
- CTT-2: Significant positive correlation with PSS (Pearson's  $r = .230^*$ ,  $p = .036$ )
- Difference score: Significant positive correlation (Pearson's  $r = 0.221^*$ ,  $p = .042$ )
- Proportion score: Significant positive correlation (Pearson's  $r = 0.224^*$ ,  $p = .040$ )
- CTT Ratio score: Significant positive correlation (Pearson's  $r = 0.264^*$ ,  $p = .015$ )
- Wrong attempts: No significant association (Pearson's  $r = -0.122$ ,  $p = 0.163$ )

## DISCUSSION

The present study examined the relationship between perceived stress and executive functioning in a normal adult population using the Color Trail Test. The findings demonstrate that perceived stress is significantly associated with performance on complex executive components of the Color Trail Test, particularly CTT-2 and derived indices such as difference, proportion, and ratio scores. In contrast, simpler attentional measures such as CTT-1 time and wrong attempts were not significantly associated with perceived stress. These results provide important insights into the selective impact of perceived stress on higher-order executive functions even in non-clinical populations.

**Perceived stress in normal adults:** The mean PSS score observed in the present study indicates moderate levels of perceived stress, which is comparable to normative data reported in Indian and international samples.<sup>[6]</sup> This suggests that the participants represent a typical community-based adult population rather than individuals experiencing extreme or pathological stress. Moderate perceived stress is increasingly common in contemporary society due to academic, occupational, and social demands, particularly in urban settings.

**Sex differences in perceived stress:** Female participants reported significantly higher perceived stress compared to males. This finding is consistent with a robust body of literature demonstrating greater stress perception and emotional distress among women across cultures.<sup>[6]</sup> Several explanations have been proposed, including increased exposure to psychosocial stressors, greater role strain, differences in emotional processing, and gender-related variations in coping strategies. Neuroendocrine studies have also demonstrated sex differences in hypothalamic–

pituitary–adrenal (HPA) axis reactivity, which may contribute to heightened stress perception in women.<sup>[7]</sup>

Despite higher perceived stress levels, female participants did not show disproportionately poorer executive performance, suggesting relative cognitive resilience. This finding aligns with previous studies indicating that subjective stress does not necessarily translate into measurable cognitive impairment in healthy individuals.

**Religion and perceived stress:** A significant association between religion and perceived stress was observed in the present study. Religion may function both as a source of stress and as a coping mechanism depending on sociocultural context, belief systems, and social support.<sup>[8]</sup> Indian studies have highlighted the complex role of religion in shaping stress perception, coping styles, and mental health outcomes. However, given unequal subgroup sizes, this finding should be interpreted cautiously and warrants further investigation.<sup>[9,10]</sup>

##### Executive functioning and Color Trail Test performance:

The Color Trail Test is particularly useful in culturally diverse populations as it minimizes linguistic and educational bias. CTT-1 primarily assesses visual attention and psychomotor speed, while CTT-2 places additional demands on cognitive flexibility, divided attention, sequencing, and inhibitory control.<sup>[9]</sup>

In the present study, perceived stress showed no significant association with CTT-1 performance, indicating that basic attentional and motor processes remain largely intact in the presence of moderate stress. This finding is consistent with experimental research suggesting that simple cognitive processes are relatively resistant to the effects of stress.<sup>[10]</sup>

In contrast, significant positive correlations were observed between perceived stress and CTT-2-time, difference score, proportion score, and ratio score. These indices are widely considered sensitive markers of executive dysfunction.<sup>[11]</sup> Increased CTT-2 time and higher derived scores reflect reduced cognitive flexibility, impaired attentional shifting, and inefficient executive control. The observed associations suggest that perceived stress selectively affects complex executive processes rather than basic attentional capacity.

**Neurobiological mechanisms:** The selective impairment of higher-order executive functions under stress can be understood in the context of stress-related neurobiological changes. Chronic or sustained stress exposure has been shown to disrupt prefrontal cortex functioning through glucocorticoid-mediated mechanisms. Animal and human studies demonstrate that stress impairs synaptic plasticity and neural connectivity in prefrontal regions, leading to deficits in cognitive flexibility and executive control.<sup>[12]</sup>

Functional neuroimaging studies further support the notion that stress preferentially affects prefrontal networks while sparing more basic sensory and motor systems.<sup>[13]</sup> This neurobiological framework provides a plausible explanation for the observed dissociation between CTT-1 and CTT-2 performance in the present study.

**Comparison with previous studies:** The findings of the present study are consistent with earlier reports demonstrating associations between stress and executive dysfunction in both clinical and non-clinical populations. Studies involving students and working adults have reported that higher perceived stress is associated with poorer performance on tasks requiring cognitive

flexibility and divided attention. Conversely, several studies have failed to demonstrate significant associations between stress and simpler cognitive tasks, supporting the present findings.<sup>[14]</sup>

In clinical populations, such as individuals with depression and anxiety disorders, executive dysfunction is more pronounced and is often accompanied by elevated stress levels.<sup>[15]</sup> The comparatively subtle associations observed in the present study highlight the importance of distinguishing between normative stress-related cognitive changes and pathological impairment.

**Clinical and research implications:** The findings of this study have important implications for psychiatric assessment and research. First, they underscore the need to consider perceived stress as a potential modifier of executive function performance, even in healthy individuals. Second, they highlight the sensitivity of complex executive measures such as CTT-2 and derived indices in detecting subtle cognitive effects of stress. Third, the results contribute to the limited Indian normative literature on stress and executive functioning.

Similar observations have been reported in an Indian community-based study by R Pangtey et al., which demonstrated that higher levels of perceived stress were significantly associated with adverse behavioral and psychosocial correlates, including sleep disturbances, substance use, and reduced overall well-being. The study also highlighted that stress was more prevalent among younger adults and those exposed to socioeconomic and environmental pressures, reinforcing the role of stress as an important determinant of cognitive and mental health outcomes in the Indian population.<sup>[16]</sup>

**Limitations and future directions:** The study's cross-sectional design limits causal conclusions, reliance on self-reported stress may not reflect physiological responses, and unequal subgroup sizes could reduce statistical power. Future research should use longitudinal designs, include objective stress measures, and evaluate stress-reduction interventions.

## CONCLUSION

The study found that participants experienced a moderate level of perceived stress. Female participants reported higher stress compared to males, and participants of one religious group showed higher perceived stress than another. Several measures of Colour Trail Test performance were positively associated with perceived stress, indicating that higher stress may be linked to less efficient cognitive processing. However, some aspects of the test, such as initial performance and errors, were not related to stress. Overall, these results suggest that both demographic factors and cognitive functioning can influence perceived stress levels.

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## Conflicts of interest

There are no conflicts of interest.

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